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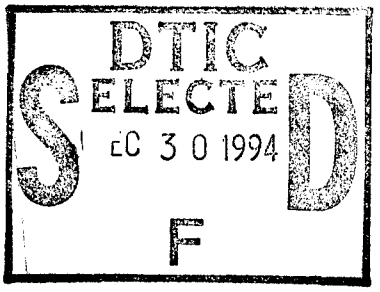
DOCUMENT NUMBER

IMPROVED HARDNESS RHA WELDABILITY AND MATERIAL PROPERTY TESTING



TECHNICAL REPORT
DOCUMENT TITLE

FINAL

DECEMBER 1994

PREPARED UNDER CONTRACT NUMBER

DAAL04-91-C-0040

GENERAL DYNAMICS
Land Systems Division
P.O. Box 2074, Warren, Michigan 48090-2074

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PREPARED BY _____
M. Foos

APPROVED BY _____
R. Gillette

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Land Systems Division
P.O. Box 2074, Warren, Michigan 48090-2074

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19 ABSTRACT (Continue on reverse if necessary and identify by block number) The M1-PMO, in conjuction with the US Army Research Laboratory (ARL) would like to potentially up-armor the M1 family of vehicles by increasing the hardness of rolled homogeneous armor (RHA) MIL-A-12560 steel. The basic thrust of the program is to utilize lower tempering temperatures and chemistries of slightly more hardenability to produce a RHA armor with a Rockwell "C" hardness of 39-48 without altering the current specification for MIL-A-12560 steel. It is believed that the increased hardness levels will provide increased ballistic protection against large caliber kinetic energy threats. Weldability and material property tests were performed on the improved hardness RHA steel supplied by the US ARL. The program involves basic material characterization, weldability, machinability and plate cutting studies. The material characterization was performed on two thicknesses (1.25" and 1.50"). The weldability study included Y-groove preheat testing, stud welding and maximum heat input testing. The machinability testing involved machining parts including drilling, tapping, reaming, boring and milling. Plasma and Oxy-fuel thermal cutting were studied to gauge processing of the steel by present armor vehicle fabrication. The ballistic testing was performed by US Combat Systems Test Activity (CSTA) at Aberdeen, MD. The results show the candidate steel can be processed typical to RHA steel with minor impact to welding and machining.

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83 APR edition may be used until exhausted.
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IMPROVED HARDNESS RHA
MATERIAL EVALUATION
CONTRACT NO. DAAL04-91-C-0040

1.0 INTRODUCTION

This final report prepared by General Dynamics Land Systems (GDLS) for the U.S. Army Research Technology Laboratory documents results of the series of weldability and material property evaluation tests performed by GDLS on the improved hardness rolled homogeneous armor (RHA) steel provided by the U.S. Army Research Laboratory. The work was performed pursuant to Statement of Work (SOW) included in the Request for Proposal (RFP) under Contract DAAL04-91-C-0040.

2.0 OBJECTIVE

The primary objective was to evaluate the weldability and material properties of the improved hardness rolled homogeneous armor (RHA) steel supplied by U.S. Army Research Laboratory (ARL). The U.S. ARL is investigating the potential of up-armoring the M1 family of vehicles by increasing the hardness of rolled homogeneous armor (RHA) MIL-A-12560 steel. The changes required in the chemical composition and heat treatments are not expected to cause any revisions to the current specification for MIL-A-12560 steel. The increased hardness levels may provide increased ballistic protection against large caliber kinetic energy threats. The hardness level of the steel supplied by U.S. ARL was to have a through thickness hardness of RC 39-48.

3.0 CONCLUSIONS

The material properties results of the improved hardness RHA steel met all the minimum requirements of the current MIL-A-12560 specifications. Although the material hardenability of the steel was higher than the normal RHA steel, the plate cutting operation using today's thermal cutting processes (oxy-fuel and plasma) were successful with no edge defects. Slightly lower cutting speeds had

to be used to maintain a consistent cutting edge with the improved hardness RHA steel.

Although the weldability testing (Y-groove) was performed on the Jessop steel prior to the shipment of the improved hardness steel (U.S. Steel chemistry), an increased preheat temperature was determined to be required during welding of the steel to prevent cracking. It was mutually agreed between GDLS and the Army Research Laboratory that a minimum preheat and interpass temperature of 300° F. would be maintained during welding. The ballistic H-plates were successfully fabricated at GDLS using three different weld processes. The ballistic testing of the H-plates performed by the Combat Systems Test Activity (CSTA) met the minimum requirements of CSTA TOP-211-711 "Ballistic Testing of the Armor Weldments."

The machinability testing on various parts made from the improved hardness RHA was deemed successful. All machining was done using the current tooling and parameters used to machine RHA on today's Abrams vehicles. The tool life may be reduced slightly due to the increased hardness.

4.0 RECOMMENDATIONS

All phases of this effort indicated that IRHA material, as tested, was amenable to processing by methods presently employed for manufacturing the Abrams vehicle at LATP. All cutting, welding and machining practices were successful with some minor adjustments for the material hardness. However, the scope of this evaluation did not allow for the definition of the most optimum processes.

Further investigation is necessary to determine the actual preheat requirements which will be inherent to welding the improved hardness RHA steel by plate thickness. Additional H-plate testing should be performed to qualify additional weld processes. Additional machinability testing would be required to obtain ideal tooling parameters and tool alloys to machine the improved hardness RHA steel.

5.0 DISCUSSION

5.1 Material Property Evaluation

Base plate Charpy V-notch (CVN) tests were performed on each thickness (1.25" and 1.50") of material supplied by the U.S. Army Research Laboratory. Seven (7) tests were performed on each thickness. All base metal plate CVN tests met the minimum requirement of MIL-A-12560 material. The results are shown in Attachment 1.

One welded mechanical property test plate was fabricated using two (2) 6"x12"x1.25" plates butt welded together using the high current density (HCD) weld process. Ten (10) CVN tests were performed in the heat affected zone (HAZ) of the welded plate. The weld parameters and test results are shown in Attachment 1.

All CVN tests were performed according to ASTM E23 and A370 at a temperature of -40° F. All specimens were taken transverse to the rolling direction and conducted in the T-L orientation at the plate centerline. The butt welded test specimens were notched in the heat affected zone.

Standard tensile tests were performed on each thickness (1.25" and 1.50") to determine the ultimate tensile strength (UTS), and 0.20% offset yield point, percent reduction in area, and percent elongation of the base material. All tests were performed per ASTM E8 at ambient temperature (70° F.) in both the transverse and longitudinal orientations. Duplicate tests were taken at both orientations. The test results are shown in Attachment 1.

Brinell hardness tests were taken on the top and bottom plate surfaces of each thickness (1.25" and 1.50"). Duplicate Brinell hardness readings were also taken on each Charpy bar specimen. A through thickness Rockwell "C" traverse was performed on a plate of each thickness (1.25" and 1.50"). All hardness tests were performed per ASTM E10 and E18. The hardness test results are shown in Attachment 1.

Triplicate bend tests were performed on the 1.50" thick material. The specimens were 3/8" thick across the 1.50" dimension and were 12" in length taken from the plate centerline. The three (3) specimens were bent 180° over a 1.50" diameter pin. The tests were performed in accordance with ASTM E290 by Bowser-Morner, Inc., (BMI No. 94040068). All three (3) specimens showed some small cracking. The crack lengths were 0.05" or less.

Stress corrosion tests were performed on each thickness (1.25" and 1.50") to determine the susceptibility of the material to stress corrosion cracking (SCC) following production thermal processing. Six (6) plates 6"x12" were cut from each thickness by under water plasma units and exposed to a salt fog spray. The plates were periodically monitored to determine if any edge defects/cracks associated with thermal cutting propagate out of the edge heat affected zone. The plate edges were AC and DC magnetic particle inspected as well as dye penetrant inspected prior to and after the salt fog spray operation. There were no defects/cracks observed at any time. The salt fog spray booth was maintained as required per MIL-STD-117. The test data is shown in Attachment 2.

Three (3) Jominy (1.00" diameter) bars were machined and end quench tested per ASTM-A-255 (89). The Jominy End Quench Test was performed to determine the material hardenability and the respective critical diameter (D_I). The Mini-Tech hardenability computer model was also run for the material composition and is shown in Attachment 3.

The complete chemical composition present in the steel was performed in accordance with ASTM E350 and E1019. The level of hydrogen, nitrogen, and oxygen was also determined. The tests were performed on the 1.50" thick plate and the results are shown in Attachment 4.

The microstructure of each thickness (1.25" and 1.50") was examined using standard metallographic practices to determine the microstructure at the centerline, surface, and 1/4 thickness. The specimens were prepared and macro-etched to determine the material structure, grain size, inclusion content morphology and to

quantify the amount of retained Austenite present in the steel. The test results are shown in Attachment 4.

5.2 Weldability and Thermal Cutting

Plasma cut and oxy-fuel programs were developed to cut ten (10) 6"x12" test blanks from each plate thickness (1.25" and 1.50") to define processing ability with present RHA armor vehicle fabrication methods. Macro- and microscopic metallographic evaluations and scanning electronic microscope (SEM) evaluations were performed to define the condition of the cut edge. Magnetic particle (AC and DC) and dye penetrant nondestructive tests (NDT) were performed to assess the internal soundness of the cut edge. No defects or indications were observed during the NDT tests. The results of the evaluations are shown in Attachment 5. It should be noted that slightly slower travel speeds had to be used to maintain a consistent cut edge. It was more prominent during oxy-fuel cutting as compared to the plasma cut process. The extra thick mill scale on the plate surface is believed to be the problem.

A weldability evaluation was conducted using the Y-groove method as adapted by GDLS. The evaluation was performed on the Jessop #1 and Jessop #2 steel supplied by the Army Research Laboratory prior to arrival of the improved hardness RHA steel. Evaluation was conducted on 1.50" and 2.50" thick Jessop #1 material and 1.25" thick Jessop #2 material. Preheat temperatures used on the Jessop #1 material were 300 and 400 degree F. Preheat temperatures of 200, 250, 275 and 300 degree F. were used on the Jessop #2 material. Test weld joints were flame cut and ground prepped to final configuration. Preheating was conducted using a gas rosebud torch and verified using a contact pyrometer. The material provided was sufficient to run only five tests of each thickness. The joint set-up is shown in Attachment 6.

Initially two tests were run with each thickness of Jessop #1 steel; two were run at each of the preheat levels of 300 and 400 degrees F. After a 72 hour incubation period, the weld joint was removed by flame cutting and the edges ground. The test coupons were sectioned, metallographically prepared for microscopic examination. No heat affected zone (HAZ) cracking occurred on these sections.

Data sheets 1 through 4 are enclosed in Attachment 6. A second set of tests were run on the Jessop #1 material with revised parameters. Three tests were run for each thickness. The wire speed was reduced from 375 IPM to 315 IPM in an effort to reduce penetration slightly and maintain a more desirable weld bead configuration. The second set of tests yielded no HAZ cracking. Data sheets 5 through 10 are enclosed in Attachment 6.

Five (5) tests were run at each preheat temperature on the Jessop #2 material. HAZ cracking was exhibited on four of the five samples preheated at 200° F. and one of the five samples at 250° F. No HAZ cracking was exhibited in either the 275 or the 300 degree F. tests. Data sheets 12 through 31 are shown in Attachment 6.

These initial tests indicate the Jessop #1 material is weldable under certain conditions. However, the limited number of tests yields inconclusive results. Similar testing conducted at ARL resulted in HAZ cracking. The only notable difference in the testing schemes being that the ARL test plates were machined to configuration and not flame cut.

The tests performed on the Jessop #2 material indicate an increase in the preheat temperature would be required compared to our present RHA armor to reduce the chance of cracking. Further investigation is necessary to determine the actual preheat requirements by plate thickness.

One (1) stud weld qualification plate was fabricated in accordance with MIL-STD-248. The 24"x24"x1.50" plate was plasma cut and shot blast to clean the plate surface. It was noted that not all of the hard mill scale was removed from the plate surface. Sixty (60) studs (fifteen (15) of four (4) sizes) were stud welded to the plate surface using GDLS approved welding procedure. Each stud was "bend" tested in accordance with MIL-STD-248. Ten (10) studs of each size were removed by grinding and the plate surface was dye penetrant inspected. Metallographic (cross section) evaluation was performed on one (1) stud of each size. All tests met the requirements of MIL-STD-248 with no weld failures recorded. The data sheets and photographs are enclosed in Attachment 7.

5.3 H-Plate Fabrication and Ballistic Testing

Three (3) H-plates were fabricated using the 1.50" thick improved hardness RHA steel, and one (1) H-plate was fabricated using the current 1.50" thick RHA steel used in armor tank fabrication. Three (3) different approved welding processes were used to fabricate the improved hardness H-plates.

H-plate 106	High current density (HCD)
H-plate 107	GMAW spray transfer
H-plate 108	GMAW pulsed spray transfer

The RHA H-plate (H-plate 74) was welded using the high current density welding process with the same parameters as H-plate 106. The three (3) improved hardness RHA H-plates were fabricated maintaining a 300° F. preheat and interpass temperature while the RHA H-plate maintained a 200° F. preheat and interpass temperature. The four (4) H-plates were X-ray examined to ASTM E390 Grade 2 and shipped to U.S. Army Combat System Test Activity in Aberdeen, Maryland, for ballistic testing using a 75 mm plate proof projectile. The ballistic testing met the minimum ballistic requirements. The H-plate data sheets and firing records are enclosed in Attachment 8.

5.4 Machinability Testing

CNC programs were developed to machine components from the improved hardness RHA steel to evaluate tool life and performance, stress relieving, material work hardening and coolant performance and effect. The machined components included milling, drilling, tapping, boring and reaming operations.

Six (6) ammo door support (P/N 9377636-1 MD) plates were machined from the 1.50" thick material. The machining consisted of edge milling two (2) sides, drill and tapping four (4) 1/4-20 UNC-2B holes and two (2) 3/8-16 UNC-2B holes on each plate. The same tooling and parameters were used as on today's RHA steel. All the machining operations performed satisfactory. During the drilling of the 1/4-20 UNC-2B holes, the drills began "dulling" considerably faster on the improved RHA steel as compared to the RHA steel plates. This problem could be resolved by varying the tooling and/or

the feed parameters. The part configuration and the data sheets are enclosed in Attachment 9.

Three (3) blow-off panel (P/N 12931206-1 MD) plates were machined from the 1.25" thick material. The machining consisted of face milling the plate surfaces, drill and tapping five (5) .625-11 UNC-2B holes, end milling a .55" width seal groove, drill and ream six (6) .3937 holes, drilling eight (8) .430" holes and end milling three (3) 2.750" holes on each plate. The same tooling and parameters were used as on today's RHA material. All of the machining operations performed satisfactory with no notable difference from the machining on RHA material. It should be noted that during the surface face milling, large chips (approximately .38" diameter) were noted on several inserts. The cutting edges of the insert did not wear excessive and the plate cutting surface was acceptable. The large chips could be occurring due to the hard mill scale noted on the plate surfaces. The plates were shot blast but large amounts of mill scale remained on the plate surface. The plate surfaces remained relatively flat (W/I .06") after approximately .25" material was face milled away. This stress relief characteristic of the improved hardness material showed better than the today's RHA material. The part configuration and data sheets are enclosed in Attachment 9.

ATTACHMENT 1

MATERIAL PROPERTIES DATA SHEETS

CVN TEST RESULTS

BASE PLATE CHARPY V-NOTCH (CVN) TEST RESULTS:

BREAKING ENERGY IN FT-LBS

SPECIMEN NO:	1.25" PLATE	1.50" PLATE
1	21.5	16.5
2	24.5	20.0
3	26.5	19.0
4	23.0	20.0
5	22.5	17.0
6	25.5	20.5
7	22.0	18.0
Average:	23.6	18.7

BUTT WELDED HAZ CHARPY V-NOTCH (CVN) TEST RESULTS:

BREAKING ENERGY IN FT-LBS

SPECIMEN NO:	BUTT WELDED 1.25" PLATE
1	21.5
2	65.5
3	70.0
4	75.5
5	66.0
6	109.0
7	71.0
8	64.0
9	64.0
10	62.0
Average:	71.8

NOTES: TESTS PERFORMED IN ACCORDANCE WITH ASTM E23.
TESTS PERFORMED AT -40°F.
SPECIMENS WERE TAKEN TRANSVERSE TO THE ROLLING DIRECTION AT THE PLATE CENTER LINE.
BUTT WELDED TEST SPECIMENS WERE NOTCHED IN THE HEAT AFFECTED ZONE.
TESTS WERE PERFORMED BY BOWSER-MORNER, INC (BMI NO. 94040068)

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BASE PLATE TENSILE TEST RESULTS

SPECIMEN NO:	1.25" PLATE		1.50" PLATE	
Test Direction	Longitudinal		Longitudinal	
Specimen	A	B	A	B
Dimension, inches	0.499	0.502	0.501	0.502
Area, Square inches	0.1956	0.1979	0.1971	0.1979
Tensile Strength, psi	185,500	186,000	189,800	189,100
0.2% Offset Yield Strength	165,600	164,700	169,000	168,300
% Elongation in 2.0"	13.0	14.0	14.5	15.0
Reduction of Area, %	51.4	52.5	53.1	56.8

SPECIMEN NO:	1.25" PLATE		1.50" PLATE	
Test Direction	Longitudinal		Longitudinal	
Specimen	A	B	A	B
Dimension, inches	0.499	0.502	0.505	0.497
Area, Square inches	0.1956	0.1979	0.2003	0.1940
Tensile Strength, psi	185,700	184,500	188,700	189,700
0.2% Offset Yield Strength	165,600	164,700	167,800	169,100
% Elongation in 2.0"	12.5	12.5	13.0	12.0
Reduction of Area, %	45.6	48.0	47.2	45.8

NOTES: TESTS PERFORMED IN ACCORDANCE WITH ASTM E8
TESTS PERFORMED AT 70°F.
SPECIMENS WERE MACHINED AT THE BASE PLATE CENTERLINE
TESTS WERE PERFORMED BY BOWSER-MORNER, INC (BMI NO. 94040068)

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HARDNESS TEST RESULTS

BRINELL SURFACE HARDNESS DATA

Performed in accordance with ASTM E10

Location:	1.25" Plate	1.50" Plate
Top	363	375
Bottom	375	388

Note: Tests performed using a 10-mm ball employing a 3000 Kg load

ROCKWELL 'C' HARDNESS DATA ON CVN SPECIMENS

Performed in accordance with ASTM E18

BASE PLATE SPECIMENS

Specimen No:	1.25" Plate		1.50" Plate	
	A	B	A	B
1	39.2	38.9	40.7	40.5
2	34.0	36.7	38.9	37.5
3	36.9	35.4	39.4	37.8
4	37.5	37.2	39.0	38.3
5	36.0	34.9	38.6	37.8
6	38.6	37.4	39.2	39.0
7	38.8	37.1	38.7	37.8

BUTT WELDED HAZ SPECIMENS

Specimen No:	Weld	Base Metal
1	13.9	37.5
2	13.0	39.0
3	12.9	39.0
4	13.7	39.3
5	17.5	39.1
6	22.0	38.8
7	16.0	39.0
8	15.0	37.6
9	10.0	38.9
10	13.9	37.9

Note: Weld metal hardness should have been reported in the Rockwell 'B' scale. We reported in the Rockwell 'C' scale as a better comparison of the two (2) hardness areas.
Tests were performed by Bowser-Morner, INC (BMI No. 94040068)

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LAND SYSTEMS DIVISION

HARDNESS TEST RESULTS (cont.)

ROCKWELL 'C' THROUGH HARDNESS DATA

Performed in accordance with ASTM E18

BASE PLATE SPECIMENS

Location:		1.25" Plate	1.50" Plate
Top-	1	39.2	39.0
	2	40.2	40.0
	3	40.5	40.2
	4	40.8	40.2
Center	5	39.0	41.3
	6	39.5	40.0
	7	40.3	40.7
	8	39.0	40.8
	9	39.4	38.4
Bottom	10	38.4	40.0

Note: Hardness readings were evenly spaced across the plate thickness. Tests were performed by Bowser-Morner, INC (BMI No. 94040068)

ATTACHMENT 2

STRESS CORROSION DATA SHEETS

I-RHA STRESS CORROSION DATA SHEET

PLATE I.D.	PLATE THICKNESS	DATE STARTED	1ST CHECK	2ND CHECK	3RD CHECK	RESULTS	TOTAL HOURS
IRHA-A	1.25"	JAN.28	FEB. 14	FEB.28	----------	NO CRACKS	650
IRHA-B	1.25"	JAN. 28	FEB. 14	FEB. 28	----------	NO CRACKS	650
IRHA-C	1.25"	JAN.28	FEB. 14	FEB. 28	----------	NO CRACKS	650
IRHA-D	1.25"	JAN. 28	FEB. 14	FEB.28	MARCH 21	NO CRACKS	1050
IRHA-E	1.25"	FEB. 28	MARCH 21	----------	----------	NO CRACKS	500
IRHA-F	1.25"	FEB. 28	MARCH 21	----------	----------	NO CRACKS	500
IRHA-G	1.50"	JAN. 28	FEB. 14	FEB. 28	MARCH 21	NO CRACKS	1050
IRHA-H	1.50"	JAN. 28	FEB. 14	FEB. 28	----------	NO CRACKS	650
IRHA-I	1.50"	JAN.28	FEB. 14	FEB. 28	----------	NO CRACKS	650
IRHA-J	1.50"	FEB. 28	MARCH 21	----------	----------	NO CRACKS	500
IRHA-K	1.50"	FEB. 28	MARCH 21	----------	----------	NO CRACKS	500
IRHA-L	1.50"	FEB.28	MARCH 21	----------	----------	NO CRACKS	500

NOTES: -Salt fog spray booth maintained per MIL-STD-117
-The number of plates which could be inserted at one time was limited due to the size of the salt fog spray booth
-The edges were AC and DC Magnetic Particle and Dye Penetrant inspected for indications/ cracks prior to salt spray test, at checkpoints and after test

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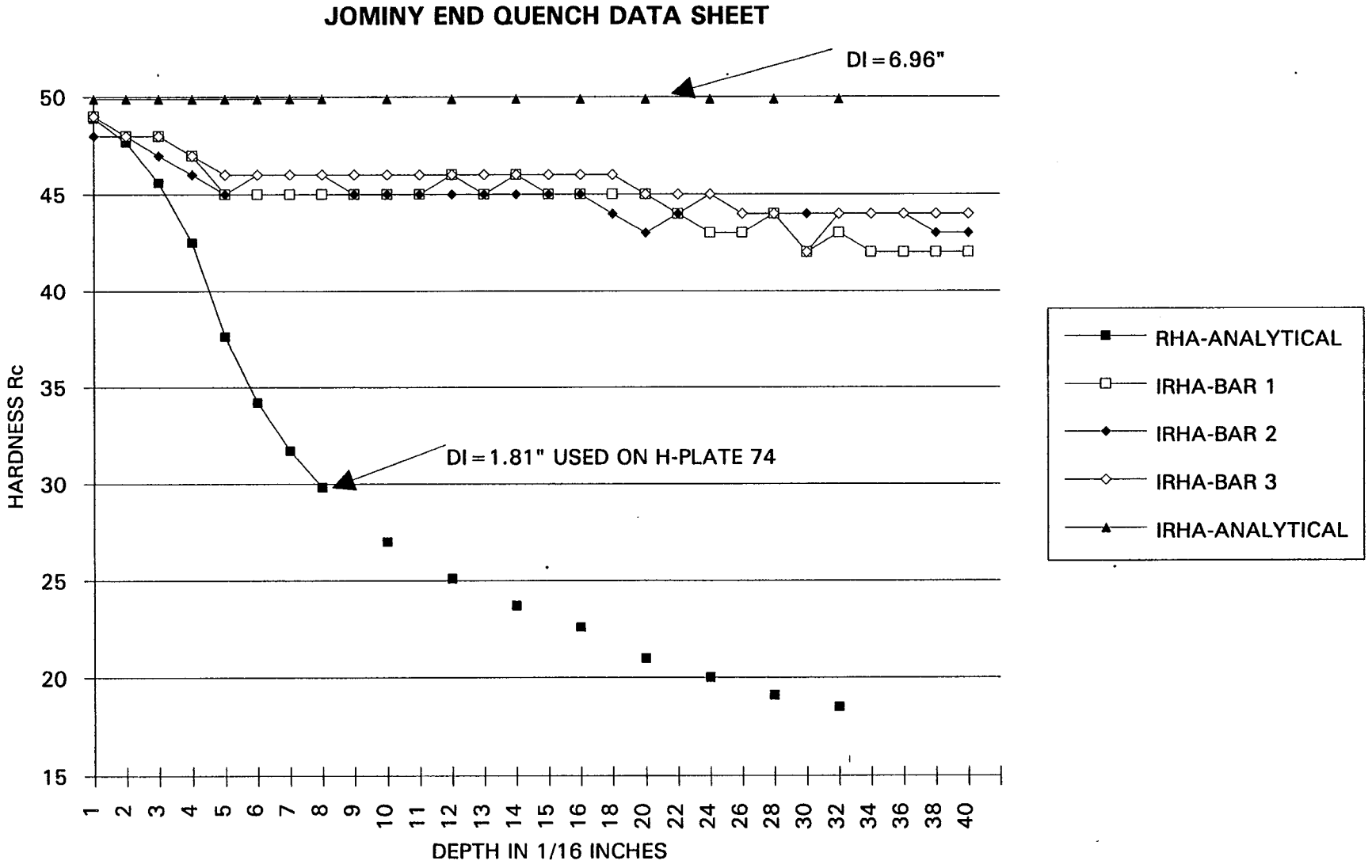
ATTACHMENT 3

JOMINY END QUENCH DATA SHEETS

ATTACHMENT 3
JOMINY END QUENCH DATA SHEET

DEPTH	RHA-ANAL.	IRHA-BAR1	IRHA-BAR2	IRHA-BAR3	IRHA-ANAL
1/16 INCHES	Rc	Rc	Rc	Rc	Rc
1	48.9	49	48	49	49.9
2	47.7	48	48	48	49.9
3	45.6	48	47	48	49.9
4	42.5	47	46	47	49.9
5	37.6	45	45	46	49.9
6	34.2	45	46	46	49.9
7	31.7	45	46	46	49.9
8	29.8	45	46	46	49.9
9		45	45	46	
10	27	45	45	46	49.9
11		45	45	46	
12	25.1	46	45	46	49.9
13		45	45	46	
14	23.7	46	45	46	49.9
15		45	45	46	
16	22.6	45	45	46	49.9
18		45	44	46	
20	21	45	43	45	49.9
22		44	44	45	
24	20	43	45	45	49.9
26		43	44	44	
28	19.1	44	44	44	49.9
30		42	44	42	
32	18.5	43	44	44	49.9
34		42	44	44	
36		42	44	44	
38		42	43	44	
40		42	43	44	

ATTACHMENT 3



ATTACHMENT 4

CHEMICAL COMPOSITION AND MICROSTRUCTURE DATA SHEETS

CHEMICAL COMPOSITION AND MICROSTRUCTURE

CHEMICAL COMPOSITION

Performed in accordance with ASTM E350 and E1019

COMPOSITION	CONTENT	PROPOSED Ni-Cr-Mo
Carbon, %	0.27	.26 - .28
Manganese, %	0.39	0.80
Sulfur, %	0.005	0.005
Phosphorous, %	0.008	0.010 Max.
Nickel, %	3.27	2.6 Min.
Chromium, %	1.49	0.80
Molybdenum, %	0.57	0.50
Silicon, %	0.35	0.30
Nitrogen, %	0.061	
Oxygen, %	0.096	
Hydrogen, %	0.023	

NOTE: The Metallurgical Test Report supplied by U. S. Steel delivered to GDLS with the steel shipment is attached to the report in Attachment 4. Test performed by Bowser-Morner, INC (BMI No. 94040068)

MICROSTRUCTURE EXAMINATION

PLATE SIZE	LOCATION:	MICROSTRUCTURE
1.25"	Surface	Tempered Martensite with a surface layer 0.05" thick that appears to be a lower Carbon Martensite than in the body of the plate material. There is an oxide or mill scale 0.002" to 0.004" thick. See Photo 1.
1.25"	0.3125" (1/4 thickness)	Tempered Martensite, See Photo 2.
1.25"	0.625" (1/2 thickness)	Tempered Martensite, See Photo 3.
1.50"	Surface	Tempered Martensite with a surface layer 0.02" thick that appears to be a lower Carbon Martensite than in the body of the plate material. There is an oxide or mill scale 0.002" to 0.0044" thick. See Photo 4.
1.50"	0.375" (1/4 thickness)	Tempered Martensite, See Photo 5.
1.50"	0.750" (1/2 thickness)	Tempered Martensite, See Photo 6.

NOTE: Tests performed by Bowser-Morner, INC (BMI No. 94040068)

CHEMICAL COMPOSITION AND MICROSTRUCTURE (cont.)

GRAIN SIZE

Grain size determined according to ASTM E112 comparison to plate I.

	1.25" Plate	1.50" Plate
ASTM Grain Size	8.0	8.0

See Photos 7 and 8

INCLUSION CONTENT

Inclusion content was determined according to ASTM E45 comparison to plate I.

	1.25" Plate	1.50" Plate
Type	D-Globular Oxides	D-Globular Oxides
Series	Heavy	Thin
Rating, Number	1.5	1.5

See Photos 9 and 10

RETAINED AUSTENITE

Performed by X-ray Diffraction Spectroscopy in accordance with ASTM E975.

	1.25" Plate	1.50" Plate
Austenite, %	Not Detected<3	Not Detected<3

NOTE: Tests performed by Bowser-Morner, INC (BMI No. 94040068)

Photo I

Near-Surface Micrograph 1.25" Plate
500x Magnification Vilella's Reagent Etch

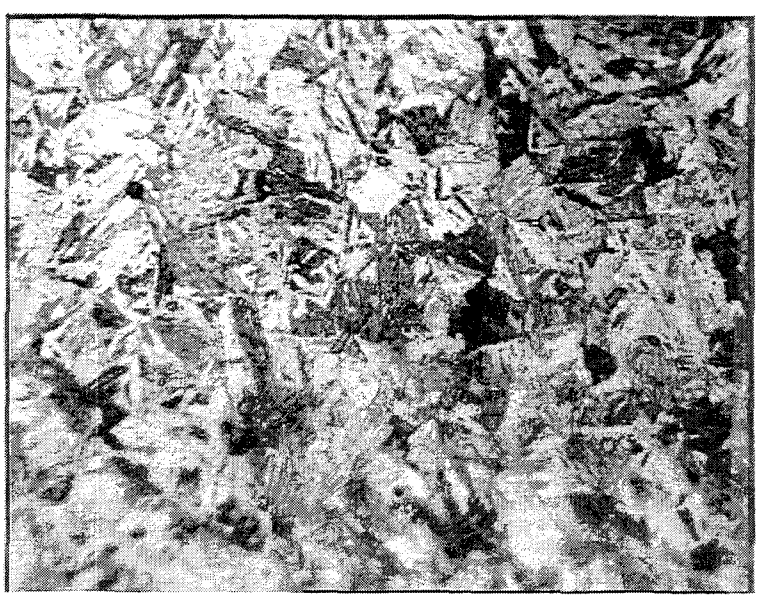
Photo II

1/4 Thickness (0.3125") Micrograph 1.25" Plate
500x Magnification Vilella's Etch

Photo III

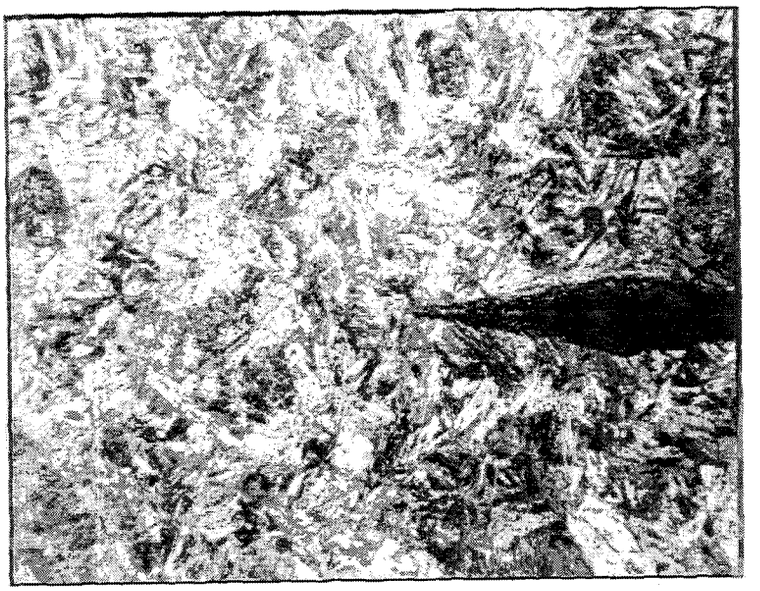
Thickness Center (0.625") Micrograph 1.25" Plate
500x Magnification Vilella's Etch

Photo IV



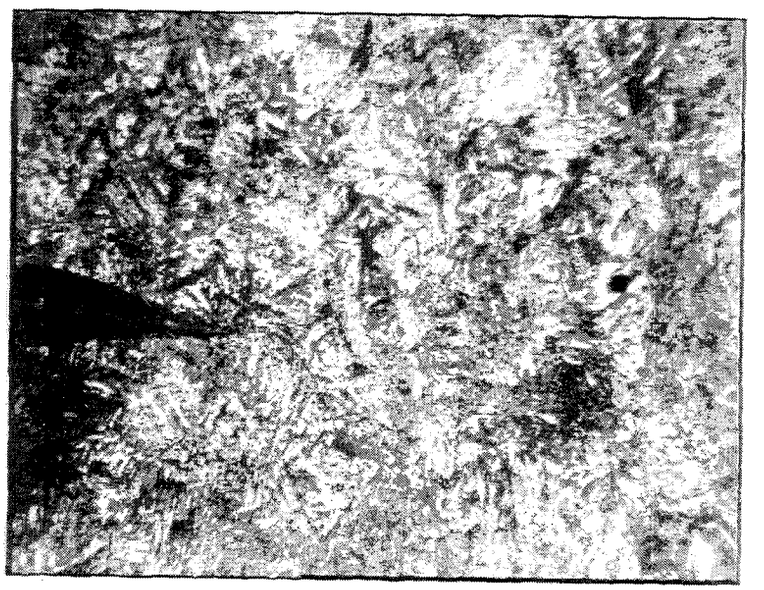
Near Surface Micrograph 1.50" Plate
500x Magnification Vilella's Etch

Photo V



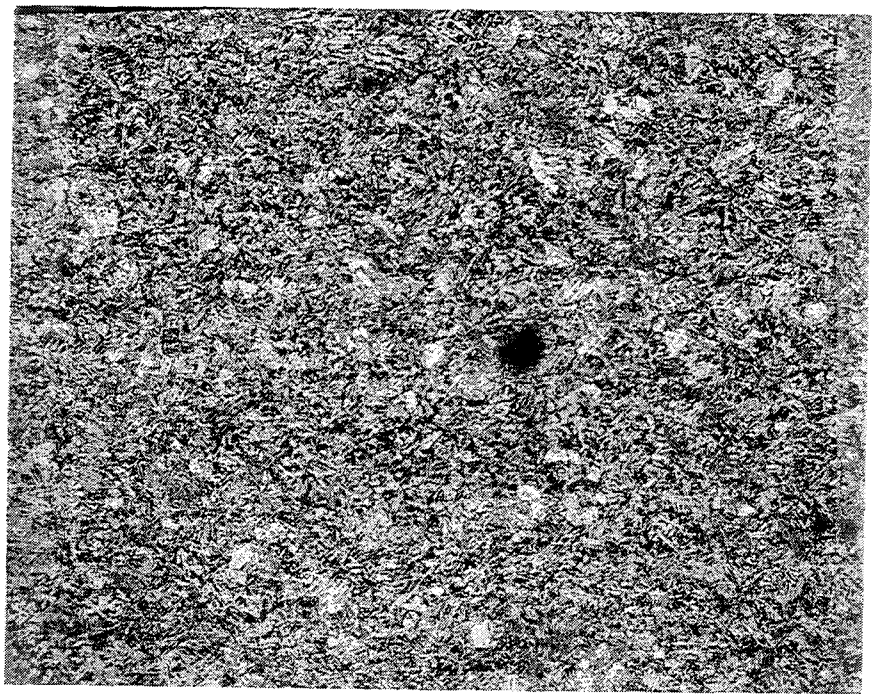
1/4 Thickness (0.375")Micrograph 1.50" Plate
500x Magnification Vilella's Etch

Photo VI



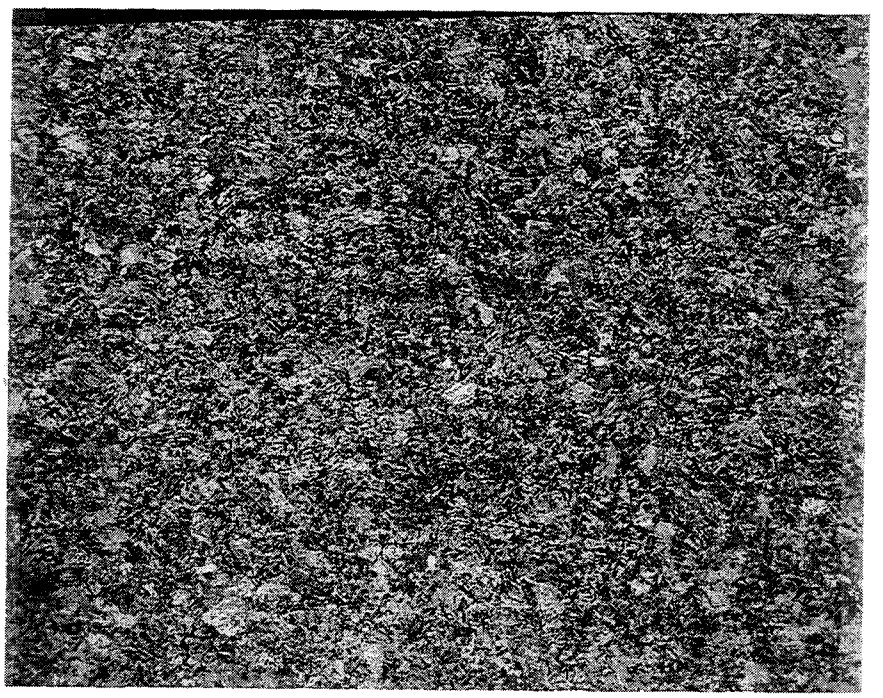
Thickness Center (0.750") Micrograph 1.50" Plate
500x Magnification Vilella's Etch

Photo VII



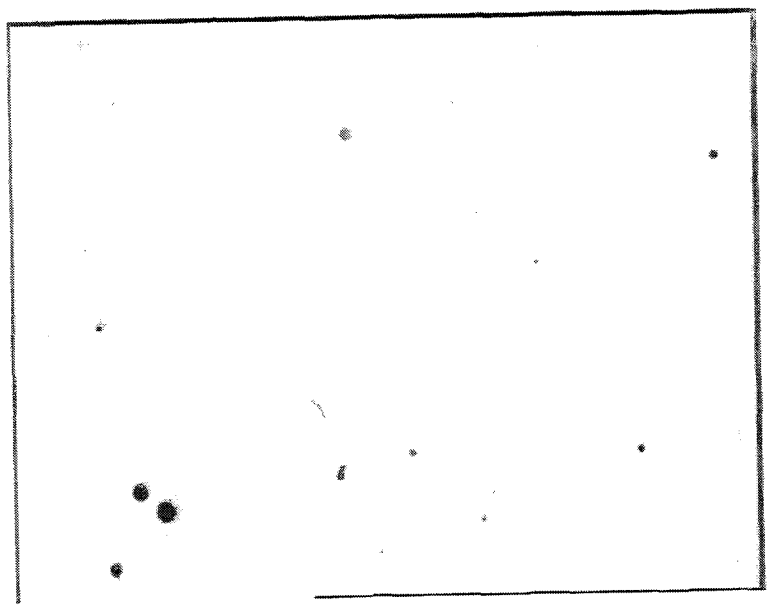
Grain Size Micrograph 1.25" Plate ASTM 8.0
100x Magnification Vilella's Etch

Photo VIII



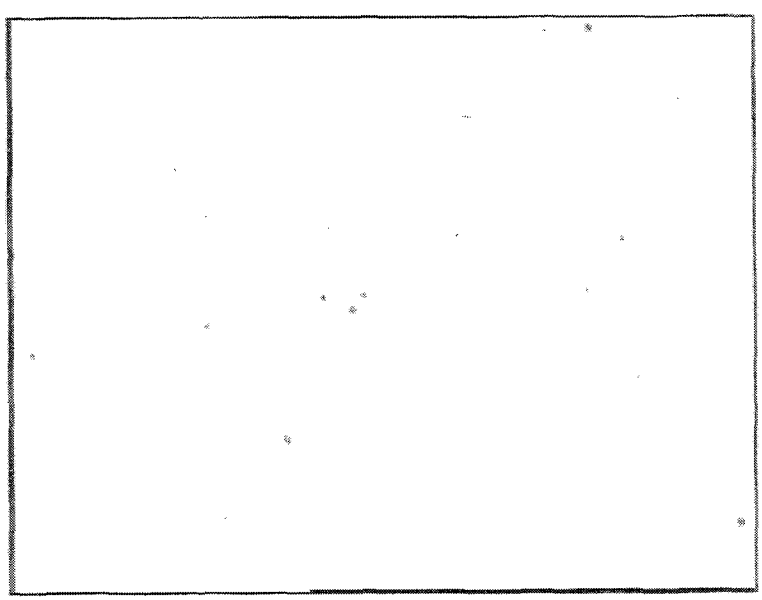
Grain Size Micrograph 1.50" Plate, ASTM 8.0
100x Magnification Vilella's Etch

Photo IX



Inclusion Content 1.25" Plate, 1.5 Heavy Type "D" Globular Oxides
100x Magnification Unetched

Photo X



Inclusion Content 1.50" Plate, 1.5 Thin Type "D" Globular Oxides
100x Magnification Unetched

ATTACHMENT 5

PLATE CUTTING DATA SHEETS

PLATE CUTTING DATA SHEET

PLATE SIZE 12" X 6" X 1.25" DATE DECEMBER 14, 1993
PLATE NUMBER HEAT T43401 PERFORMED BY MARK NIESE

OXY-FUEL CUT

MT (AC)	MT (DC)	PT
1. NO INDICATIONS	1. NO INDICATIONS	1. NO INDICATIONS
2. NO INDICATIONS	2. NO INDICATIONS	2. NO INDICATIONS
3. NO INDICATIONS	3. NO INDICATIONS	3. NO INDICATIONS
4. NO INDICATIONS	4. NO INDICATIONS	4. NO INDICATIONS
5. NO INDICATIONS	5. NO INDICATIONS	5. NO INDICATIONS
6. NO INDICATIONS	6. NO INDICATIONS	6. NO INDICATIONS
7. NO INDICATIONS	7. NO INDICATIONS	7. NO INDICATIONS
8. NO INDICATIONS	8. NO INDICATIONS	8. NO INDICATIONS
9. NO INDICATIONS	9. NO INDICATIONS	9. NO INDICATIONS
10. NO INDICATIONS	10. NO INDICATIONS	10. NO INDICATIONS

PLASMA CUT

MT (AC)	MT (DC)	PT
1. NO INDICATIONS	1. NO INDICATIONS	1. NO INDICATIONS
2. NO INDICATIONS	2. NO INDICATIONS	2. NO INDICATIONS
3. NO INDICATIONS	3. NO INDICATIONS	3. NO INDICATIONS
4. NO INDICATIONS	4. NO INDICATIONS	4. NO INDICATIONS
5. NO INDICATIONS	5. NO INDICATIONS	5. NO INDICATIONS
6. NO INDICATIONS	6. NO INDICATIONS	6. NO INDICATIONS
7. NO INDICATIONS	7. NO INDICATIONS	7. NO INDICATIONS
8. NO INDICATIONS	8. NO INDICATIONS	8. NO INDICATIONS
9. NO INDICATIONS	9. NO INDICATIONS	9. NO INDICATIONS
10. NO INDICATIONS	10. NO INDICATIONS	10. NO INDICATIONS

PLATE CUTTING DATA SHEET

PLATE SIZE 12" X 6" X 1.50"
PLATE NUMBER HEAT T43401

DATE DECEMBER 15, 1993
PERFORMED BY MARK NIESE

OXY-FUEL CUT

MT (AC)	MT (DC)	PT
1. NO INDICATIONS	1. NO INDICATIONS	1. NO INDICATIONS
2. NO INDICATIONS	2. NO INDICATIONS	2. NO INDICATIONS
3. NO INDICATIONS	3. NO INDICATIONS	3. NO INDICATIONS
4. NO INDICATIONS	4. NO INDICATIONS	4. NO INDICATIONS
5. NO INDICATIONS	5. NO INDICATIONS	5. NO INDICATIONS
6. NO INDICATIONS	6. NO INDICATIONS	6. NO INDICATIONS
7. NO INDICATIONS	7. NO INDICATIONS	7. NO INDICATIONS
8. NO INDICATIONS	8. NO INDICATIONS	8. NO INDICATIONS
9. NO INDICATIONS	9. NO INDICATIONS	9. NO INDICATIONS
10. NO INDICATIONS	10. NO INDICATIONS	10. NO INDICATIONS

PLASMA CUT

MT (AC)	MT (DC)	PT
1. NO INDICATIONS	1. NO INDICATIONS	1. NO INDICATIONS
2. NO INDICATIONS	2. NO INDICATIONS	2. NO INDICATIONS
3. NO INDICATIONS	3. NO INDICATIONS	3. NO INDICATIONS
4. NO INDICATIONS	4. NO INDICATIONS	4. NO INDICATIONS
5. NO INDICATIONS	5. NO INDICATIONS	5. NO INDICATIONS
6. NO INDICATIONS	6. NO INDICATIONS	6. NO INDICATIONS
7. NO INDICATIONS	7. NO INDICATIONS	7. NO INDICATIONS
8. NO INDICATIONS	8. NO INDICATIONS	8. NO INDICATIONS
9. NO INDICATIONS	9. NO INDICATIONS	9. NO INDICATIONS
10. NO INDICATIONS	10. NO INDICATIONS	10. NO INDICATIONS

PLATE CUTTING DATA SHEET

HARDNESS TRAVERSE READINGS

OXY-FUEL CUT			PLASMA CUT	
1.25"	1.50"	THICKNESS	1.25"	1.50"
		DISTANCE FROM CUT EDGE		
RC 54	RC 53	.03"	RC 48	RC 49
RC 49	RC 53	.05"	RC 48	RC 54
RC 49	RC 49	.07"	RC 48	RC 54
RC 50	RC 53	.09"	RC 42	RC 39
RC 41	RC 42	.11"	RC 45	RC 47
RC 43	RC 50	.13"	RC 42	RC 44
RC 45	RC 48	.15"	RC 42	RC 48
RC 44	RC 48	.21"	RC 42	RC 48
RC 44	RC 48	.27"	RC 42	RC 48
RC 44	RC 48	.33"	RC 42	RC 44

NOTE: HARDNESS TESTS WERE PERFORMED WITH A TUKON HARDNESS TESTER

MACROSCOPIC AND MICROSCOPIC EVALUATIONS -

THE EVALUATIONS OF THE MACROSCOPIC AND MICROSCOPIC SPECIMENS REVEALED NO CRACKS OR LINEAR INDICATIONS.

SCANNING ELECTRONIC MICROSCOPE EVALUATIONS -

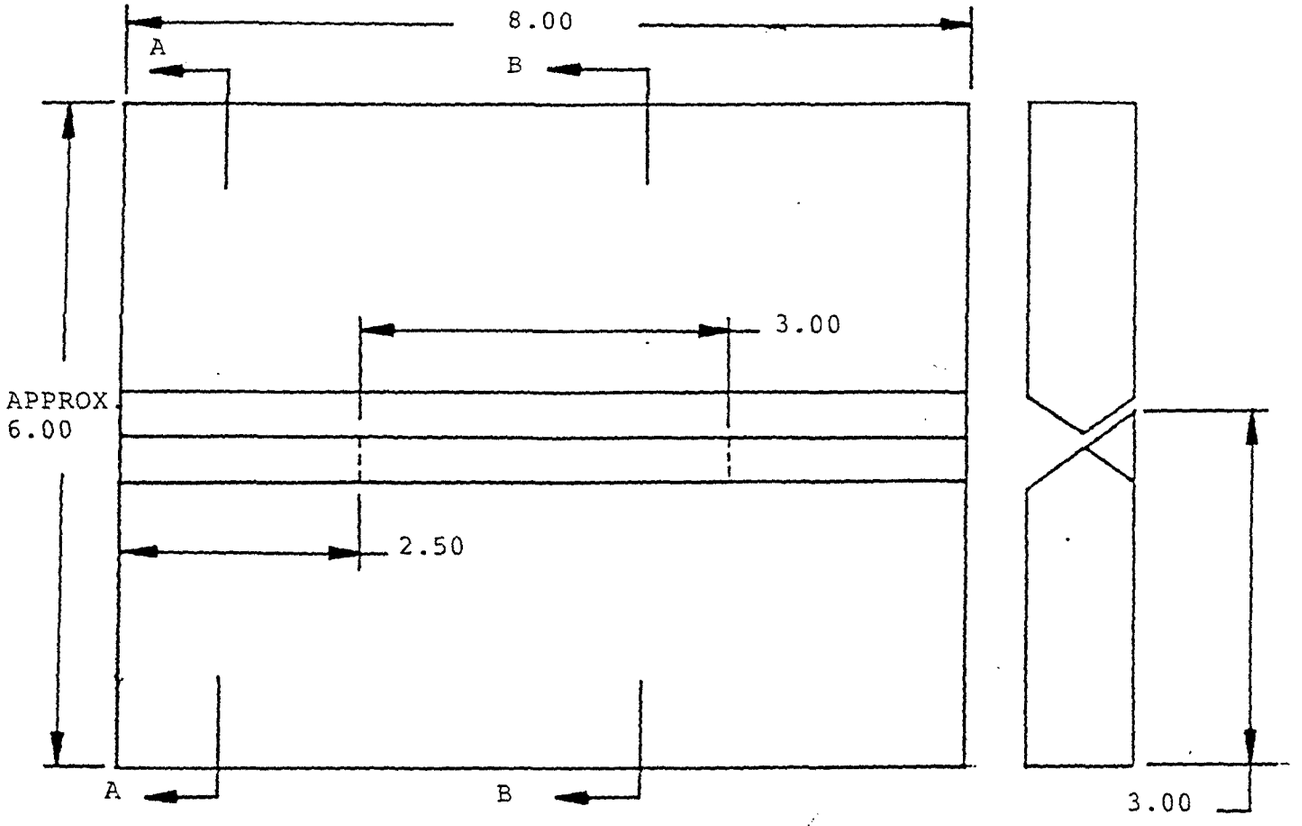
THERE WERE NO OBSERVED CRACKS IN THE SURFACE OF THE CUT EDGES AT 1000X MAGNIFICATION.

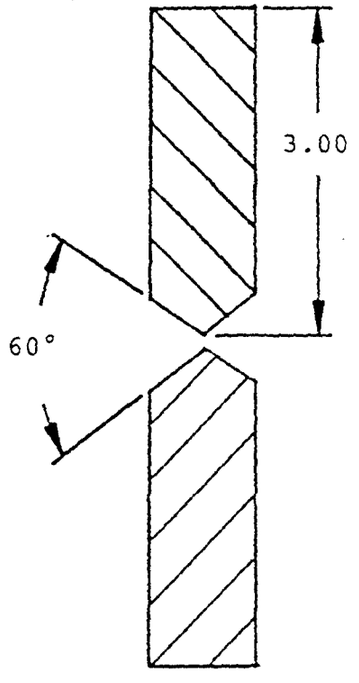
NOTE: THE SEM EVALUATIONS WERE PERFORMED BY BOWSER-MORNER, INC (BMI NO. 94040068)

ATTACHMENT 6

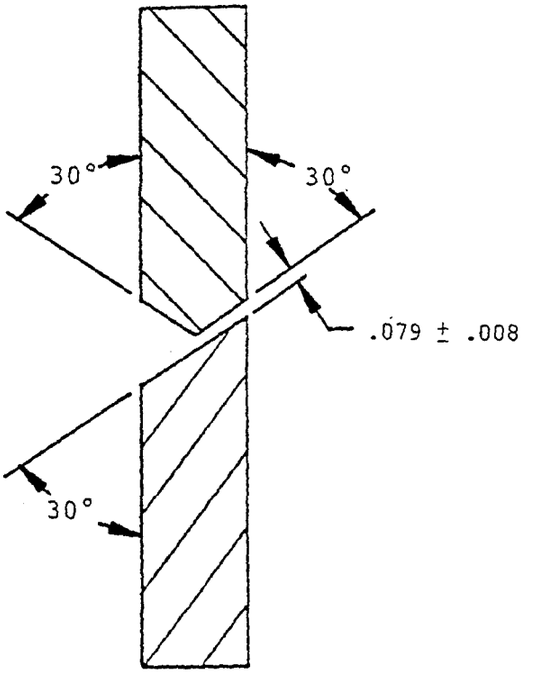
WELDABILITY DATA SHEETS

Y-GROOVE TEST PLATE ASSSEMBLY





SECTION A-A



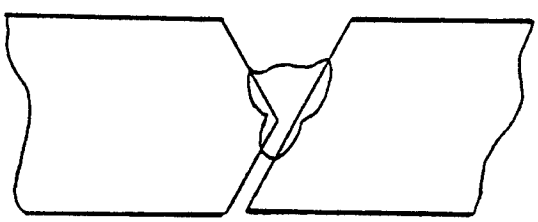
SECTION B-B

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-1	WELD PROCESS	GMAW
DATE	10-18-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	2.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	300° F
AMPERAGE	250	INTERPASS (MAX.)	N/A
WIRE SPEED	375 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	13 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	32.3 KJ		
SHIELDING GAS	95 Ar-5 $\cdot$ O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

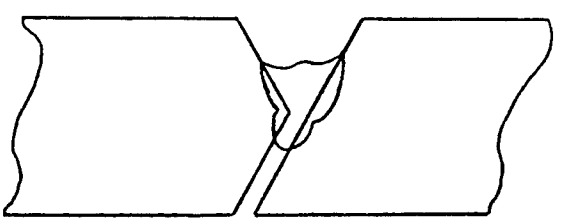
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-2	WELD PROCESS	GMAW
DATE	10-18-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	1.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	300° F
AMPERAGE	250	INTERPASS (MAX.)	N/A
WIRE SPEED	375 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	13 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	32.3 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

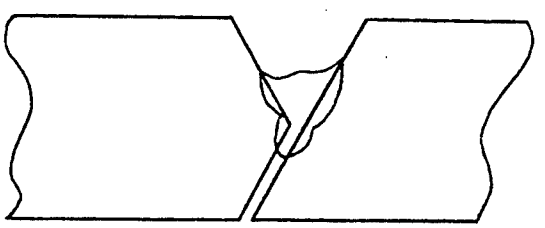
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-3	WELD PROCESS	GMAW
DATE	10-18-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	2.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	400° F
AMPERAGE	250	INTERPASS (MAX.)	N/A
WIRE SPEED	375 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	13 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	32.3 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

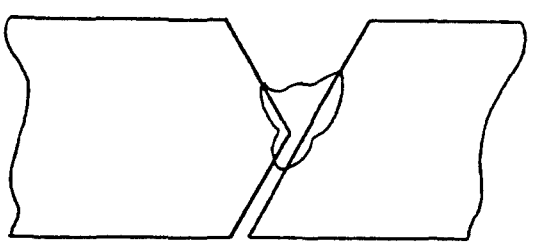
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-4	WELD PROCESS	GMAW
DATE	10-18-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	1.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	400° F
AMPERAGE	250	INTERPASS (MAX.)	N/A
WIRE SPEED	375 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	13 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	32.3 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

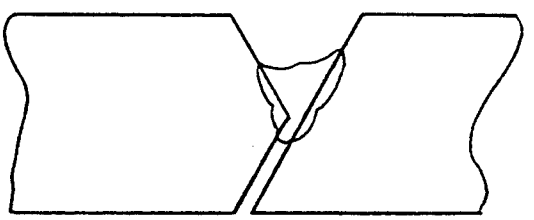
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-5	WELD PROCESS	GMAW
DATE	10-24-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	2.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	300° F
AMPERAGE	210	INTERPASS (MAX.)	N/A
WIRE SPEED	315 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	12 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	29.4 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

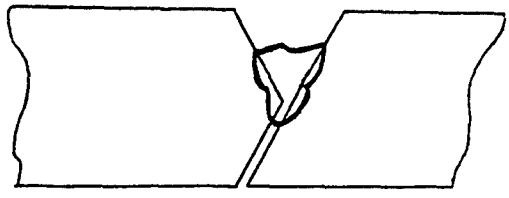
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-6	WELD PROCESS	GMAW
DATE	10-24-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	1.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	300° F
AMPERAGE	210	INTERPASS (MAX.)	N/A
WIRE SPEED	315 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	12 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	29.4 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

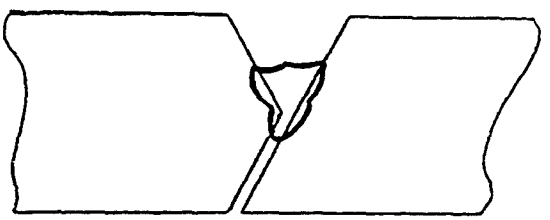
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-7	WELD PROCESS	GMAW
DATE	10-24-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	2.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	400° F
AMPERAGE	210	INTERPASS (MAX.)	N/A
WIRE SPEED	315 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	12 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	29.4 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

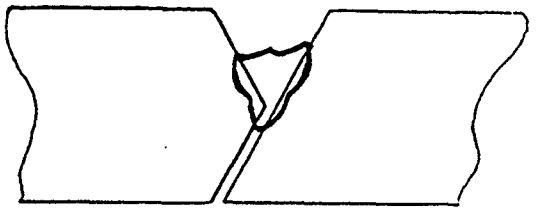
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-8	WELD PROCESS	GMAW
DATE	10-24-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	1.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	400° F
AMPERAGE	210	INTERPASS (MAX.)	N/A
WIRE SPEED	315 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	12 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	29.4 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

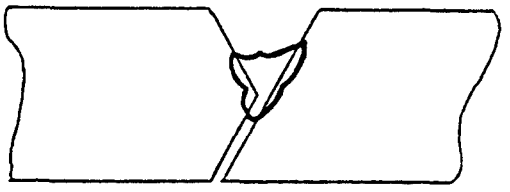
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-9	WELD PROCESS	GMAW
DATE	10-24-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	2.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	300° F
AMPERAGE	210	INTERPASS (MAX.)	N/A
WIRE SPEED	315 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	12 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	29.4 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

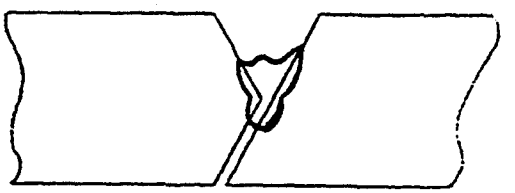
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	1-10	WELD PROCESS	GMAW
DATE	10-24-91	BASE MATERIAL	IRHA
PROGRAM	IRHA	THICKNESS	1.50"
ENGINEER	E. JOHNSON	TYPE	JESSOP 1

VOLTAGE	28.0	PREHEAT (MIN.)	300° F
AMPERAGE	210	INTERPASS (MAX.)	N/A
WIRE SPEED	315 IPM	ELECTRODE STICK-OUT	
TRAVEL SPEED	12 IPM	TIP RECESS	.25"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	29.4 KJ		
SHIELDING GAS	95 Ar-5 O_2		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75"		
ROOT OPENING	.079		
AMBIENT TEMPERATURE/ HUMIDITY			
CURRENT TYPE AND POLARITY	DC/EP		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	NO CRACK		

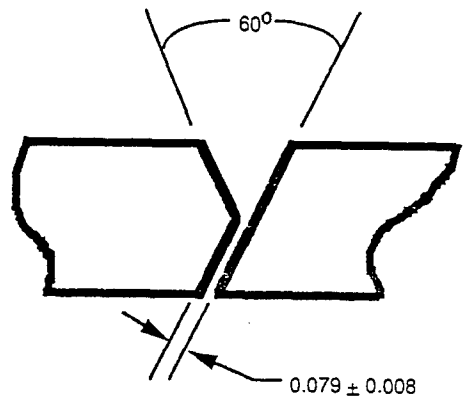
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-12	WELD PROCESS	GMAW-SPRAY
DATE	5-28-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	200° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/54.5%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	CRACKED		CRACKED

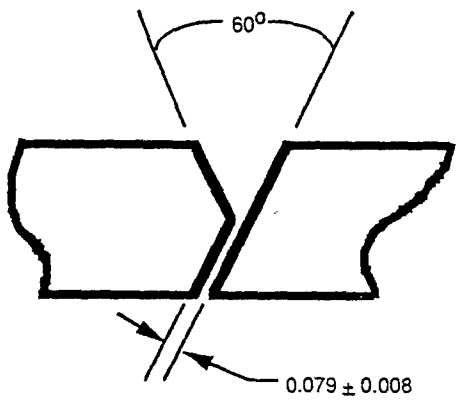
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABIL'TY TEST DATA SHEET

TEST NO.	L-13	WELD PROCESS	GMAW-SPRAY
DATE	5-28-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	F. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	200° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/54.5%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	CRACKED	CRACKED	CRACKED

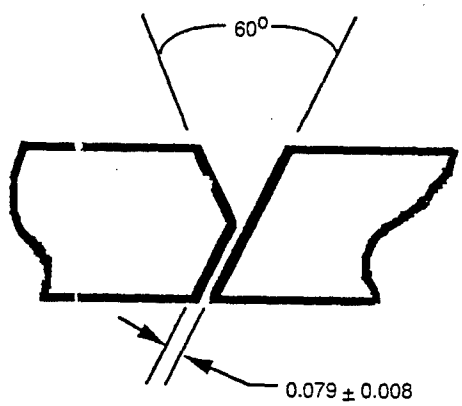
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-14	WELD PROCESS	GMAW-SPRAY
DATE	5-28-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	200° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/54.5%		
CURRENT TYPE AND POLARITY	DC/EL. POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
	CRACKED	CRACKED	CRACKED

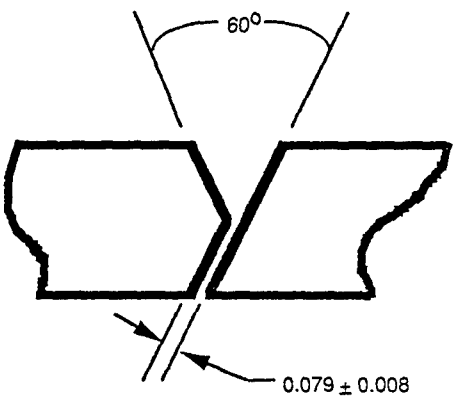
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-15	WELD PROCESS	GMAW-SPRAY
DATE	5-28-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	F. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	200° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/54.5%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

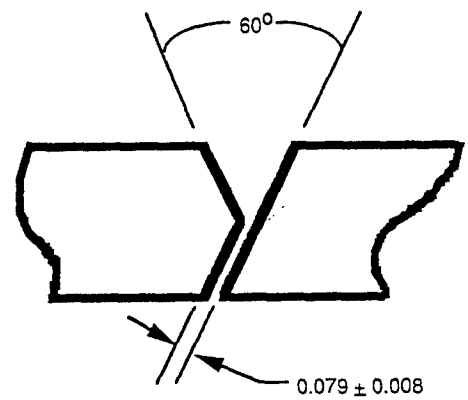
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-16	WELD PROCESS	GMAW-SPRAY
DATE	5-28-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	200° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/54.5%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
CRACKED	CRACKED	CRACKED	CRACKED

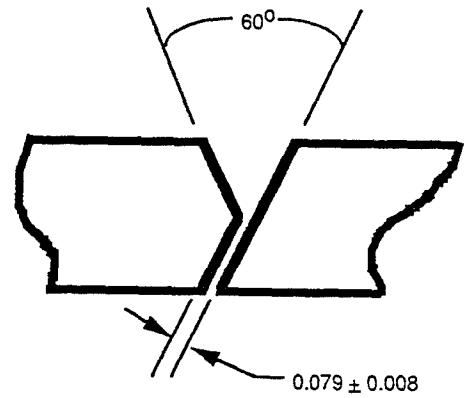
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-17	WELD PROCESS	GMAW-SPRAY
DATE	6-10-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	250° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

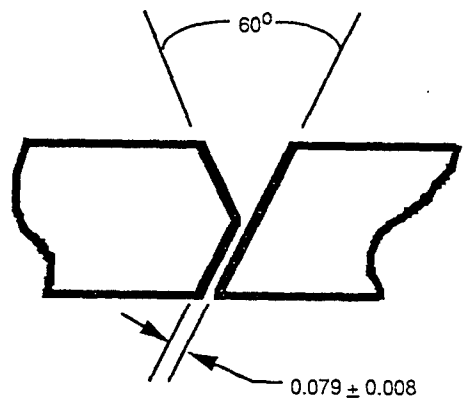
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-18	WELD PROCESS	GMAW-SPRAY
DATE	6-10-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	250° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

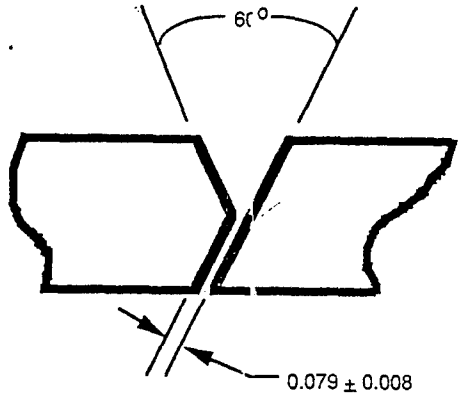
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-19	WELD PROCESS	GMAW-SPRAY
DATE	6-10-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS 1

VOLTAGE	27.0	PREHEAT (MIN.)	250° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	CRACKED	NO CRACK	CRACKED

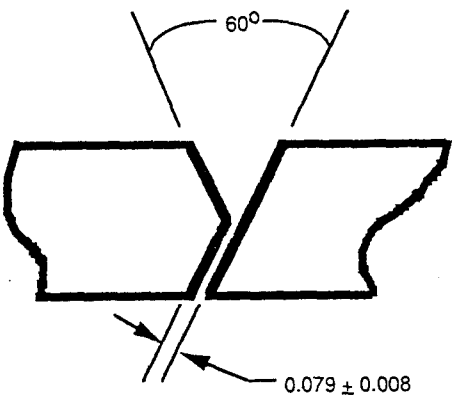
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-20	WELD PROCESS	GMAW-SPRAY
DATE	6-10-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS 1

VOLTAGE	27.0	PREHEAT (MIN.)	250° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

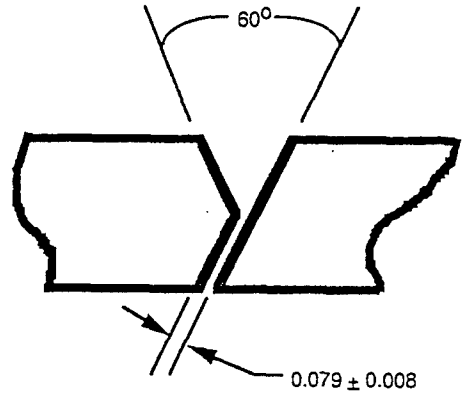
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-21	WELD PROCESS	GMAW-SPRAY
DATE	6-10-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	250° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	78° F/60%		
CURRENT TYPE AND POLARITY	DC/EL. POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

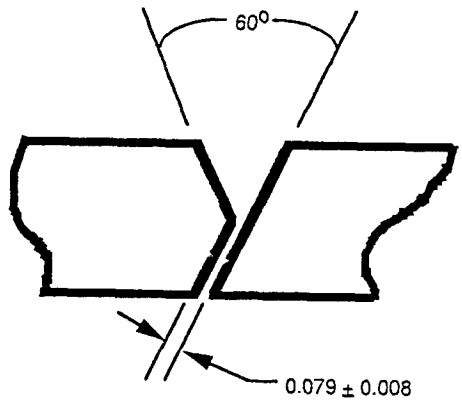
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-22	WELD PROCESS	GMAW-SPRAY
DATE	6-9-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	300° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	84° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

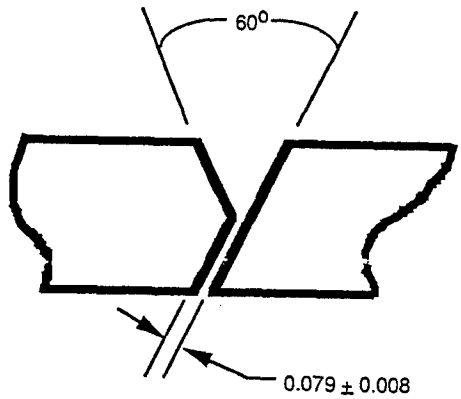
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-23	WELD PROCESS	GMAW-SPRAY
DATE	6-9-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	300° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	EC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	84° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

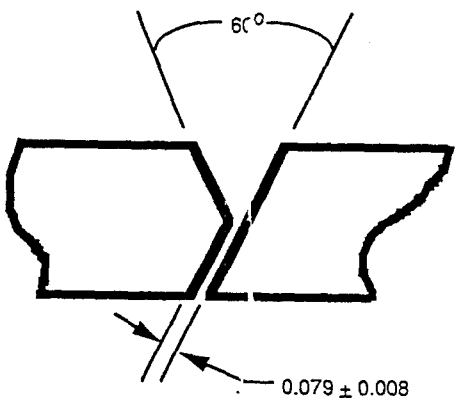
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-24	WELD PROCESS	GMAW-SPRAY
DATE	6-9-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS 1

VOLTAGE	27.0	PREHEAT (MIN.)	300° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	84° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

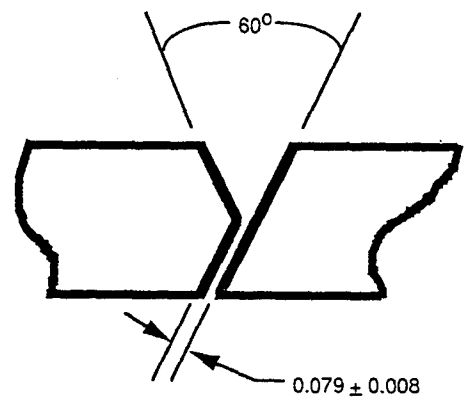
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-25	WELD PROCESS	GMAW-SPRAY
DATE	6-9-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	300° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	84° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

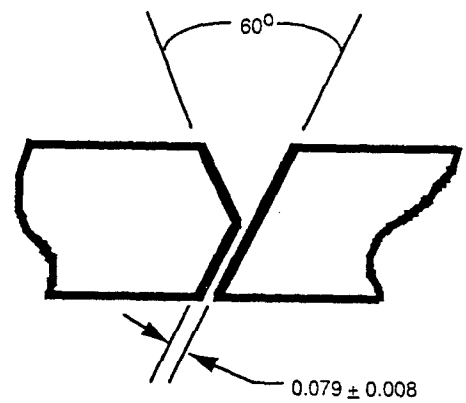
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-26	WELD PROCESS	GMAW-SPRAY
DATE	6-9-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS 1

VOLTAGE	27.0	PREHEAT (MIN.)	300° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	84° F/60%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

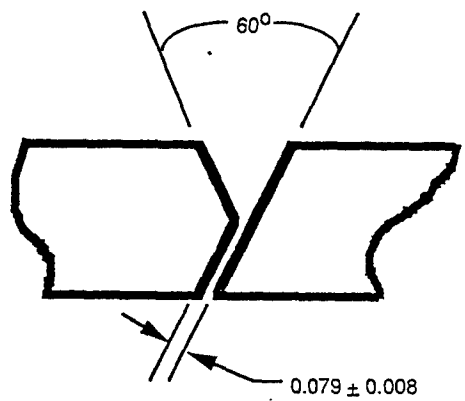
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-27	WELD PROCESS	GMAW-SPRAY
DATE	6-19-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	275° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	83° F/67%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

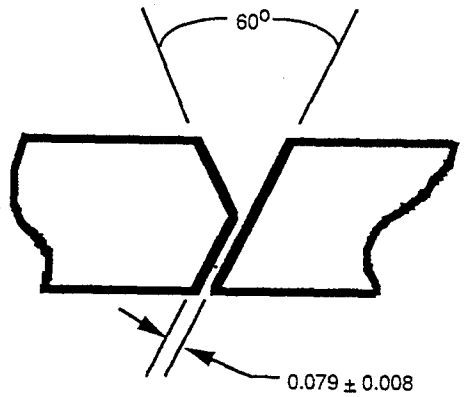
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-28	WELD PROCESS	GMAW-SPRAY
DATE	6-19-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	275° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY -	83° F/67%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

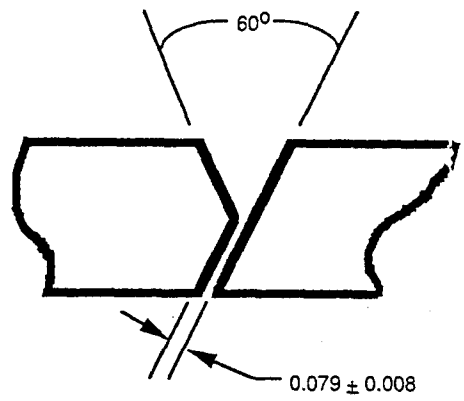
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-29	WELD PROCESS	GMAW--SPRAY
DATE	6-19-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	275° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	83° F/67%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

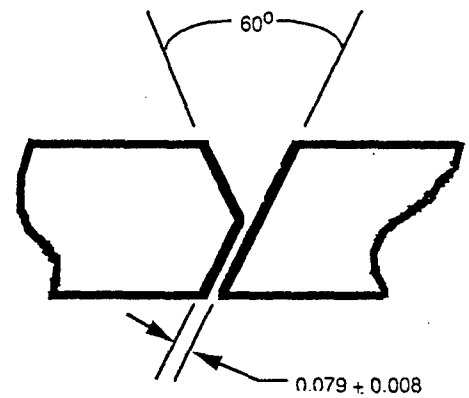
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-30	WELD PROCESS	GMAW-SPRAY
DATE	6-19-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	275° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY	83° F/67%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

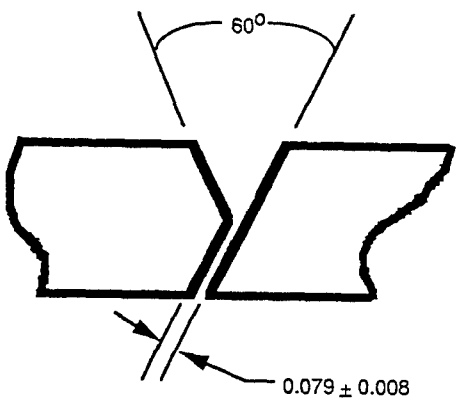
NOTES

GENERAL DYNAMICS

Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-31	WELD PROCESS	GMAW-SPRAY
DATE	6-19-92	BASE MATERIAL	JESSUP
PROGRAM	IRHA	THICKNESS	1.250"
ENGINEER	E. JOHNSON	TYPE	CLASS I

VOLTAGE	27.0	PREHEAT (MIN.)	275° F
AMPERAGE	220	INTERPASS (MAX.)	500°
WIRE SPEED	300 IPM	ELECTRODE STICK-OUT	.750"
TRAVEL SPEED	8.57 IPM	TIP RECESS	.125"
WIRE TYPE	LINCOLN LA-100	POSITION	FLAT
DIA.	.045	EDGE PREP	FC/GRIND
CONTROL NO.	C1113FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		
ROOT OPENING	.079"		
AMBIENT TEMPERATURE/ HUMIDITY -	83° F/67%		
CURRENT TYPE AND POLARITY	DC/EL POS		



JOINT DETAIL

TEST RESULTS

SECTION A	SECTION B	SECTION C	COMMENTS
NO CRACK	NO CRACK	NO CRACK	NO CRACKS

NOTES

ATTACHMENT 7

STUD WELD
DATA SHEETS

G.D.L.S. STUD WELD DATA SHEET

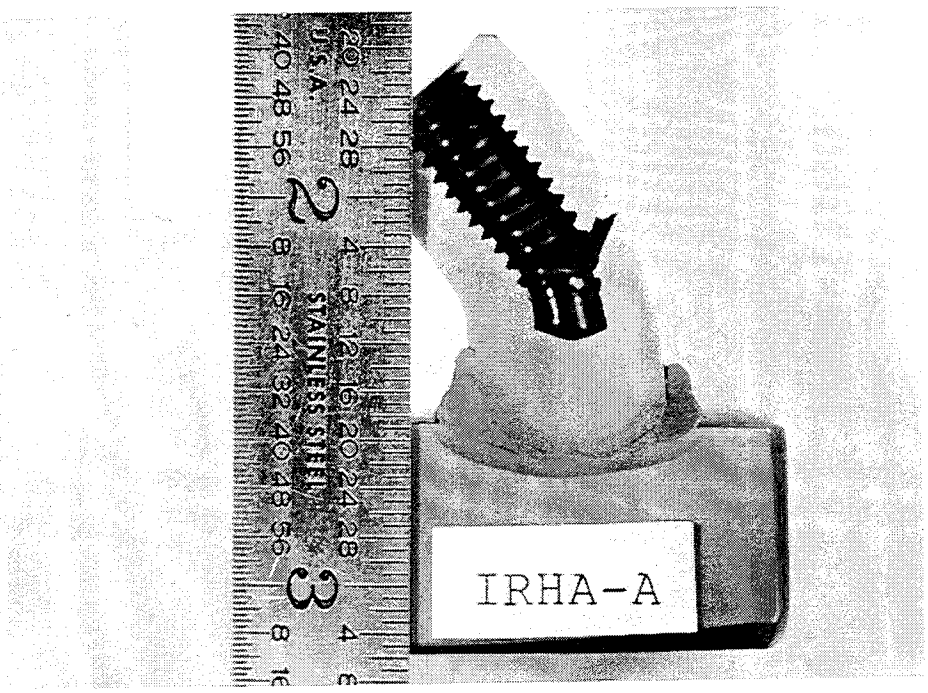
PLATE SIZE 14" x 20" x 1.50"
PLATE MATERIAL IMPROVED RHA
MACHINE TYPE TRW NELSON TR-2400
SURFACE CONDITION SHOT BLAST

DATE MAY 2, 1994
WELDED BY ED JOHNSON

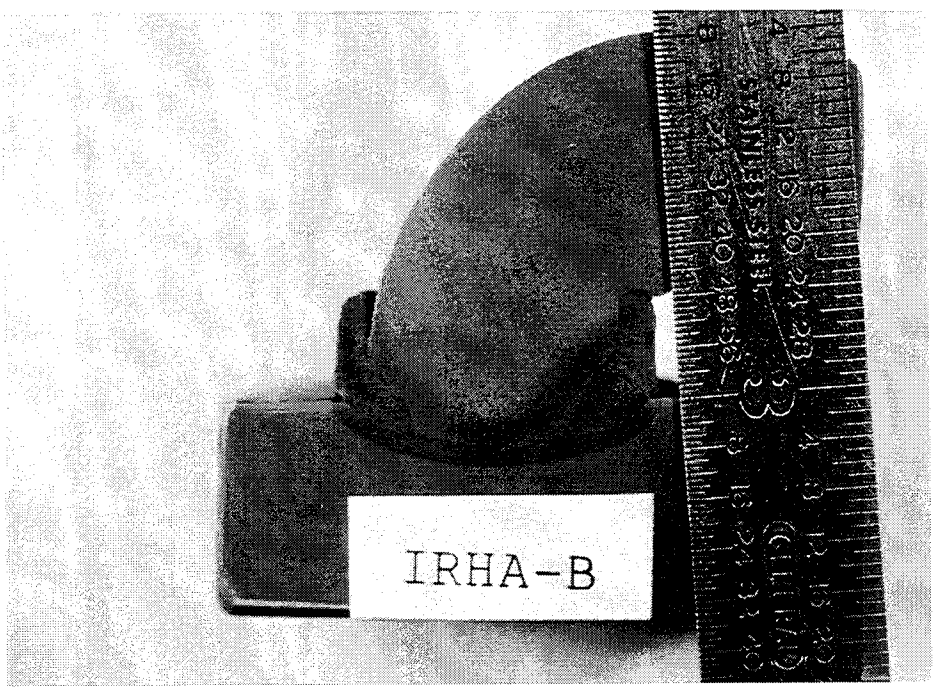
SETTINGS \ PART NO.	12337637-4	12337637-26	12323577-8	12323577-2
STUD MATERIAL	MILD STEEL	MILD STEEL	S. STEEL	S. STEEL
THREAD SIZE	1/4-20UNC-2B	1/4-20UNC-2B	3/4-10UNC-2A	1/2-13UNC-2A
STUD DIAMETER	0.50"	0.625"	0.75"	0.50"
LIFT	0.062"	0.062"	0.093"	0.093"
PLUNGE	.190"	.190"	.280"	.185"
DAMPENING	2.50	2.50	2.50	2.50
CURRENT/POLARITY	DCEN	DCEN	DCEN	DCEN
WELD POSITION	FLAT	FLAT	FLAT	FLAT
FREE TRAVEL	.125"	.125"	.125"	.190"
AMPERAGE	750	1050	1400	650
TIME (SECONDS)	0.50	0.60	0.675	0.43
# STUDS WELDED	15	15	15	15
#STUDS BEND TESTED	10	10	10	10
BEND TEST RESULTS	10 STUDS FAIL - NO WELDS FAIL	NO STUDS FAIL - NO WELDS FAIL	10 STUDS FAIL - NO WELDS FAIL	NO STUDS FAIL - NO WELDS FAIL
#STUDS DYE PENT. INSPECTED	10	10	10	10
DYE PENT. RESULTS	NO CRACKS	NO CRACKS	NO CRACKS	NO CRACKS
METALOGRAPHIC EVALUATION RESULTS	100% FUSION	100% FUSION	100% FUSION	100% FUSION

TESTS PERFORMED PER MIL-STD.248

ATTACHMENT 7 - STUD WELD QUALIFICATION

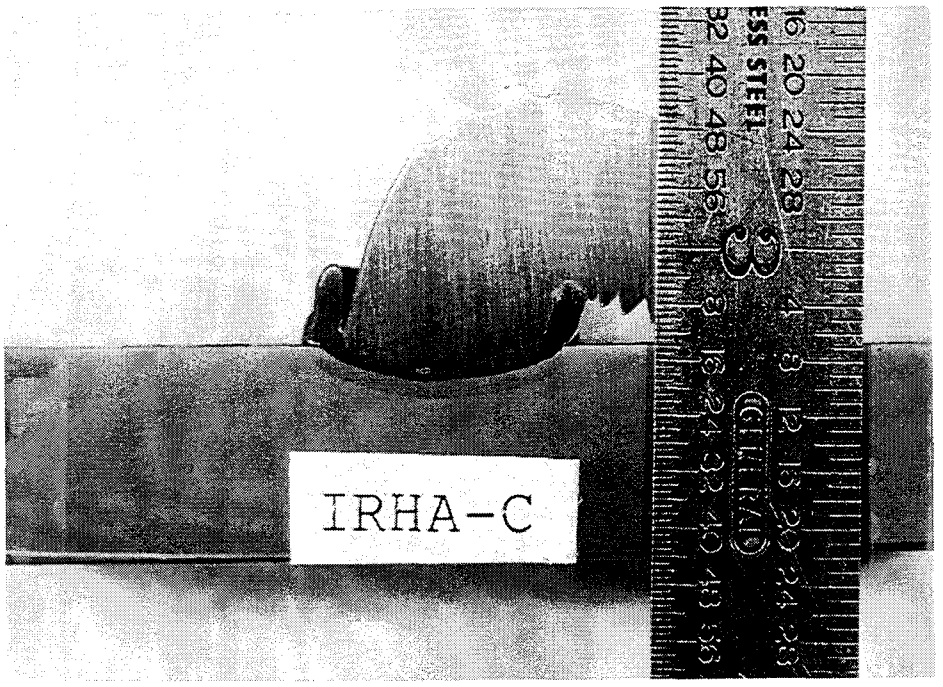


BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	MILD STEEL
STUD SIZE	0.50" DIAMETER

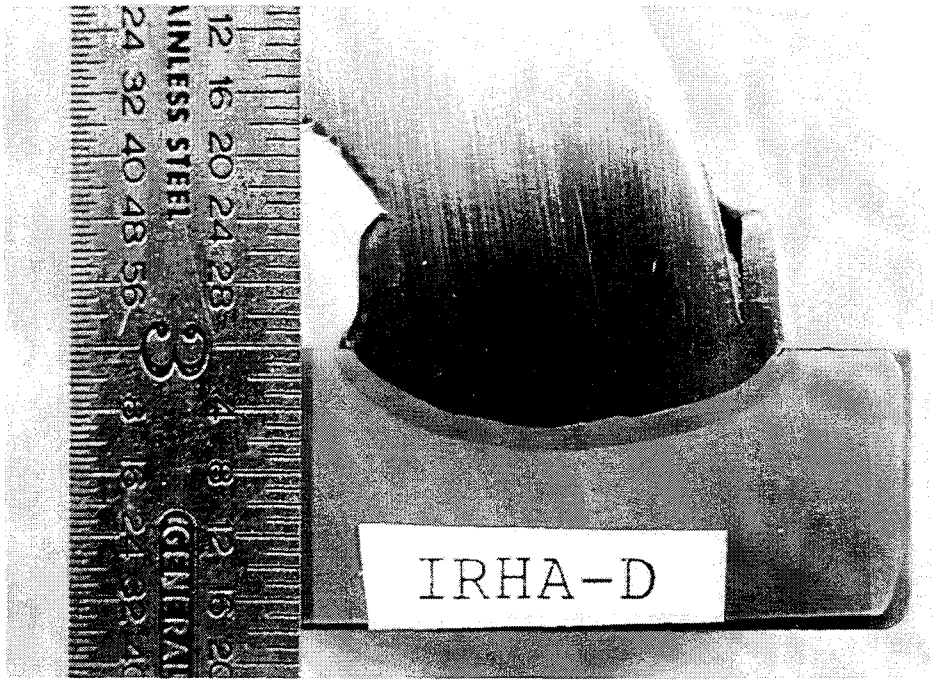


BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	MILD STEEL
STUD SIZE	0.625" DIAMETER

ATTACHMENT 7 - STUD WELD QUALIFICATION

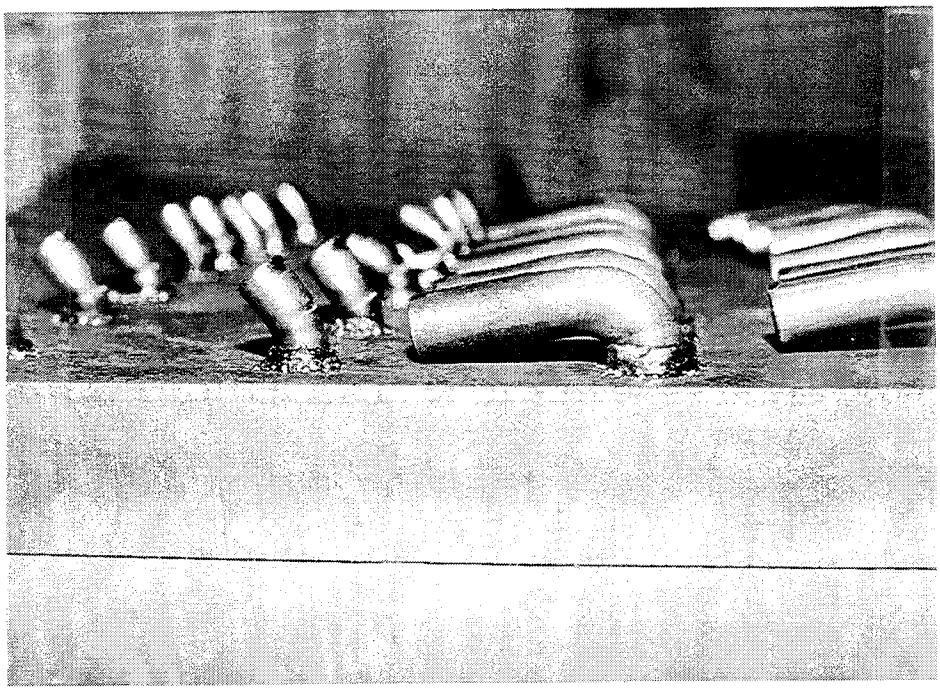


BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	STAINLESS STEEL
STUD SIZE	0.50" DIAMETER

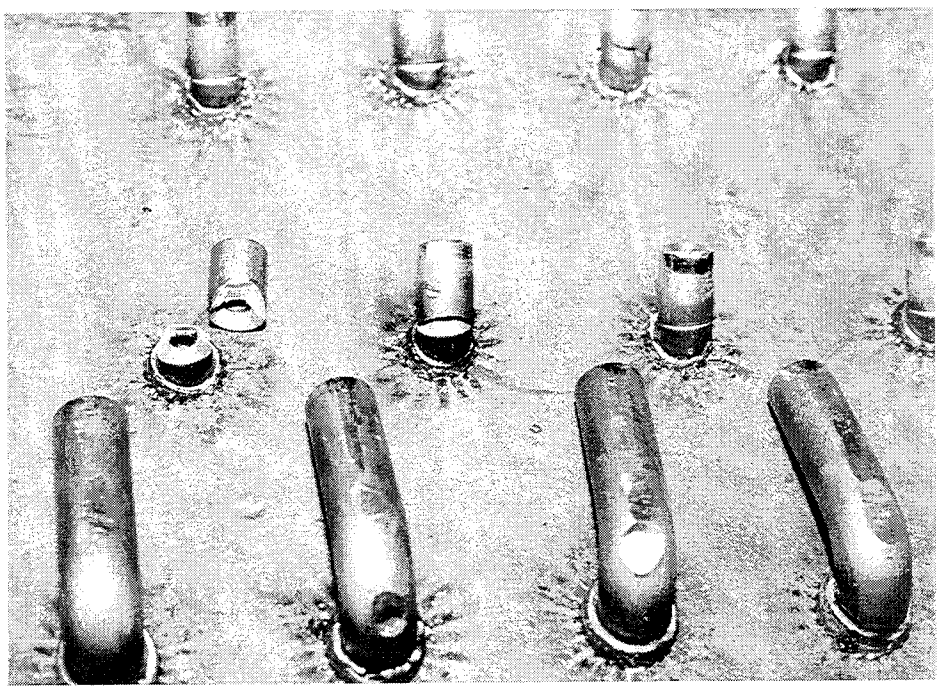


BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	STAINLESS STEEL
STUD SIZE	0.75" DIAMETER

ATTACHMENT 7 - STUD WELD QUALIFICATION
TYPICAL BEND TEST RESULTS

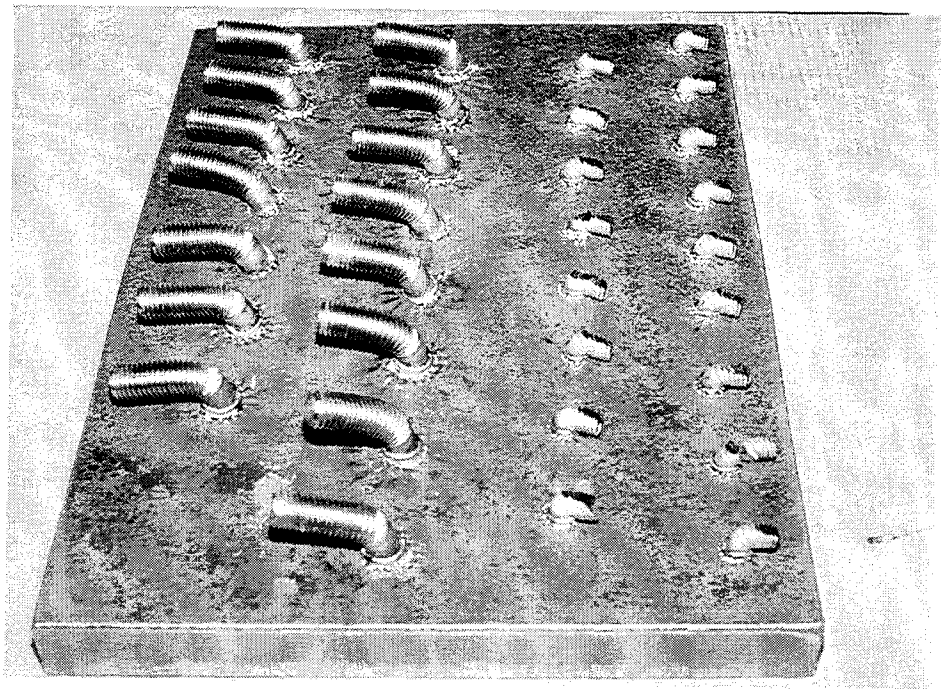


BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	MILD STEEL
STUD SIZE	0.50" AND 0.625" DIAMETER

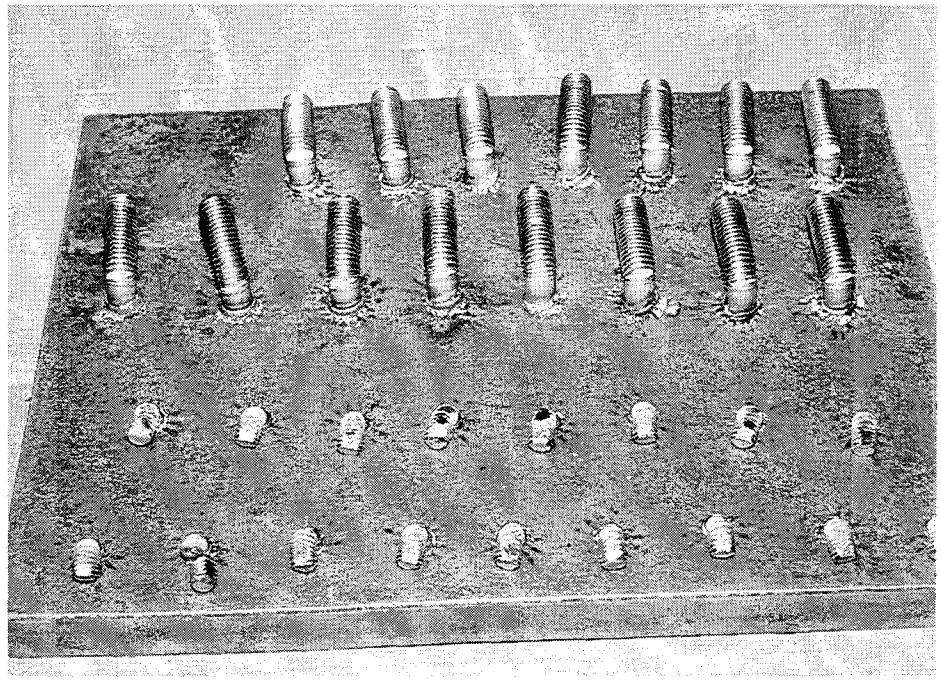


BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	MILD STEEL
STUD SIZE	0.50" AND 0.625" DIAMETER

ATTACHMENT 7 - STUD WELD QUALIFICATION
TYPICAL BEND TEST RESULTS



BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	STAINLESS STEEL
STUD SIZE	0.50" AND 0.75" DIAMETER



BASE METAL	IMPROVED HARDNESS RHA
STUD MATERIAL	STAINLESS STEEL
STUD SIZE	0.50" AND 0.75" DIAMETER

ATTACHMENT 8

H-PLATE FABRICATION AND BALLISTIC DATA SHEETS

GENERAL DYNAMICS
LAND SYSTEMS DIVISION

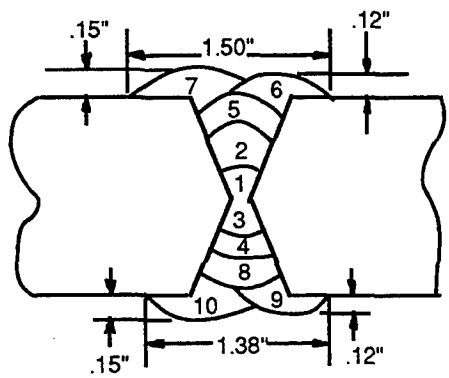
FORM 1

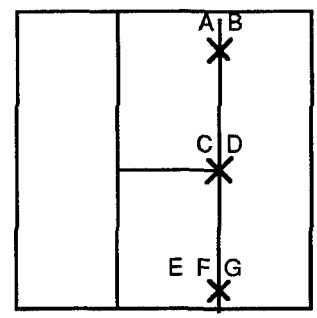
WELD ARMOR DATA

REPORT NO:
SHEET 1 OF 6

PLATE NO: 74	SUBMITTED BY: GENERAL DYNAMICS
DATE: APRIL 10, 1992	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: RHA ARMOR	
WELDED BY: DAVID HOLLON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





RIGHT LEG

Weld reinforcement ~~(has)~~ (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC/ROBOT	
PREHEAT: 200 F	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

BACKGRIND

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	295	26.8	451	39" / 3:14	200	200	200
2	.045	S	WB	395	32.1	752	40" / 2:18	205	210	205
3	.045	S	WB	285	26.6	450	40" / 3:33	205	210	208
4	.045	S	WB	400	32.1	752	41" / 2:16	205	205	210
5	.045	S	WB	437	38.0	1000	40" / 2:04	200	200	200
6	.045	S	WB	457	38.0	1000	40" / 2:38	205	210	210
7	.045	S	WB	439	38.0	1000	40" / 2:38	210	210	215
8	.045	S	WB	427	38.0	1000	40" / 2:05	200	200	200
9	.045	S	WB	442	38.0	1000	40" / 2:40	205	205	205
10	.045	S	WB	448	38.0	1000	40" / 2:40	205	210	210
11										
12			NOTE: ROTARY FILE ALL STARTS AND STOPS							
13										
14										

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET 2 OF 6

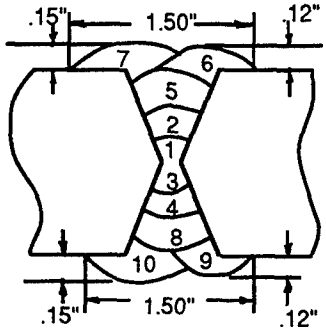
PLATE NO: 74	SUBMITTED BY: GENERAL DYNAMICS
DATE: APRIL 14, 1992	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040

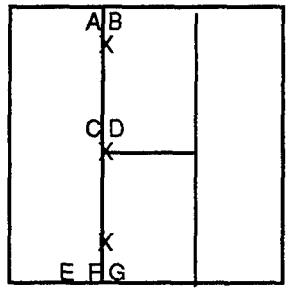
ORDNANCE MATERIAL CONCERNED: RHA ARMOR

WELDED BY: DAVID HOLLON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





LEFT LEG

Weld reinforcement ~~(has)~~ (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC / ROBOTIC (DCEP)	
PREHEAT: 200 F	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	285	26.7	450	41" / 5:05	205	210	210
2	.045	S	WB	400	32.1	750	41" / 2:35	210	215	215
3	.045	S	WB	285	26.7	450	41" / 5:05	200	200	205
4	.045	S	WB	400	32.1	750	41" / 2:35	205	205	210
5	.045	S	WB	407	38.0	1000	41" / 2:13	205	205	210
6	.045	S	WB	415	38.0	1000	41" / 2:38	210	210	215
7	.045	S	WB	416	38.0	1000	41" / 2:38	215	215	220
8	.045	S	WB	446	38.0	1000	41" / 2:03	200	200	200
9	.045	S	WB	444	38.0	1000	41" / 2:38	205	205	210
10	.045	S	WB	445	38.0	1000	41" / 2:38	210	210	215
11										
12			NOTE: ROTARY FILE ALL STARTS AND STOPS							
13										
14										

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

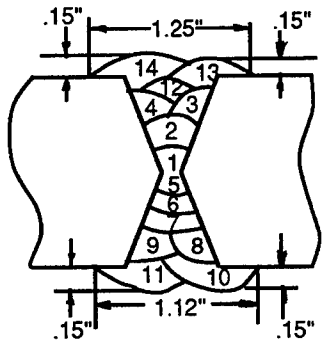
FORM 1

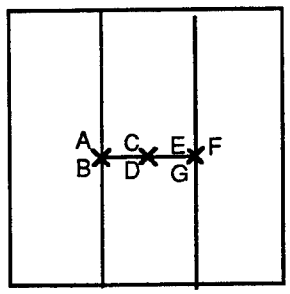
WELD ARMOR DATA

REPORT NO:
SHEET 3 OF 6

PLATE NO: 74	SUBMITTED BY: GENERAL DYNAMICS
DATE: APRIL 21, 1992	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: RHA ARMOR	
WELDED BY: DAVID HOLLON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





CROSS-BAR

Weld reinforcement ~~(has)~~ (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC (DCEP)	
PREHEAT: 200 F	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F)		
								A-B	C-D	E-F-G
1	.045	S	WB	295	26.7	451	8.25 / 0:46	205	210	205
2	.045	S	WB	300	26.7	451	9.25 / 0:45	210	210	206
3	.045	S	WB	295	26.7	451	9.62 / 0:29	210	215	216
4	.045	S	WB	295	26.7	451	9.62 / 0:32	205	210	210
5	.045	S	WB	285	26.7	450	8.25 / 0:43	200	200	200
6	.045	S	WB	395	32.1	750	8.75 / 0:36	205	208	207
7	.045	S	WB	295	26.7	450	10.25 / 0:30	205	209	207
8	.045	S	WB	325	26.7	450	10.25 / 0:27	205	210	210
9	.045	S	WB	425	36.0	950	11.25 / 0:28	210	215	210
10	.045	S	WB	450	36.0	950	11.50 / 0:30	210	215	210
11	.045	S	WB	295	26.7	450	10.25 / 0:35	200	208	200
12	.045	S	WB	325	26.7	450	10.25 / 0:28	200	205	200
13	.045	S	WB	460	36.1	950	11.25 / 0:27	202	205	200
14	.045	S	WB	460	36.0	951	11.25 / 0:28	200	205	200

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 2

ARMOR PLATE DATA

REPORT NO:

SHEET 4 OF 6

PLATE NO: 74	PLATE "A"	PLATE "B"
MANUFACTURER:	Lukens Steel	
TYPE:	Wrought Homogenous Armor Plate	
THICKNESS:	1.50"	
HEAT NO:		
LOT NO:		
PROCESS:	AC / DQ	

CHEMICAL COMPOSITION

	C	MN	SI	P	S	CR	NI	MO	ZR	V	CU
TEST #1	.2724	1.270	.2476	.0092	.0038	.1495	.1187	.5149	.0000	.0053	.2065
TEST #2											

HEAT TREATING DATA

HEAT TREATED BY:

ELECTRODE DATA

TABLE I

SIZE	MANUFACTURER	TRADE NAME	TYPE	CLASS
.045"	Lincoln Electric	LA - 100	Mil- E-23765/2	Mil-100S-1

TABLE II

MANUFACTURER TRADE NAME AND SIZE	CHEMICAL ANALYSIS									
		C	MN	SI	S	P	CR	NI	MO	CO
LA - 100 / .045"	CORE WIRE	.0455	1.311	.2979	.0057	.0047	.0494	1.784	.4146	.0023
	WELD METAL									
	CORE WIRE									
	WELD METAL									
	CORE WIRE									
	WELD METAL									

TABLE III (AUTOMATIC WELDING)

MANUFACTURER	TRADE NAME	SIZE	FLUX

RADIOGRAPHED BY:

RADIOGRAPH SERIAL NO.

REMARKS: The procedure used in fabricating the crossbar weld **(is)** ~~**(is not)**~~ the same as the procedure used in fabricating the leg welds.

FABRICATOR REPRESENTATIVE	RESIDENCE INSPECTOR OF ORDNANCE
Mark Nuss	

FORM 3

WELD RADIOGRAPHIC REPORT

(1) REPORT NO.

SHEET NO 5 OF 6

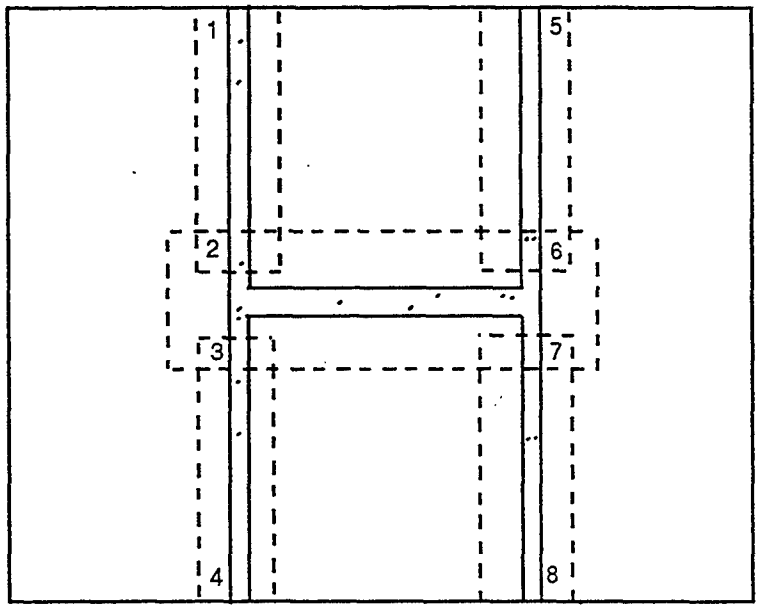
(2) X-RAY SERIAL NO: HP # 74

(3) PLATE SUBMITTED BY: GDLS	(4) PLATE NO. HP #74	(5) SPEC. ASTM-E390
(6) RADIOGRAPHED BY: GDLS	(7) DATE: 4/24/92	

(8) PLATE THICKNESS: 1.5"	(9) KV 420 KV	(10) MA 10 MA	(11) TIME 2.4 MIN.	(12) FOCAL DIST. 42"
(13) TYPE OF FILM KODAK 'M'		(14) SCREENS OR FILTERS .010 F & B		

SHOCK TEST PLATE

SHOWING LOCATION OF RADIOGRAPHS AND RESULTS OF TESTS



(15) LEGEND: CRACK; INCOMPLETE FUSION; INCOMPLETE PENETRATION; POROSITY AND SLAG INCLUSIONS; UNDERCUTTING

(16) RESULTS

1-2 SCATTERED POROSITY - STD I

3-4 SCATTERED POROSITY - STD I

5-6 SCATTERED POROSITY - STD I

7-8 SCATTERED POROSITY - STD I

X-BAR SLAG AND SCATTERED POROSITY - STD I

(17) NEGATIVES READ BY: L. N. Seay

(18) GOV'T Q. A. REP. John W. Brown

4/24/92

FORM 4

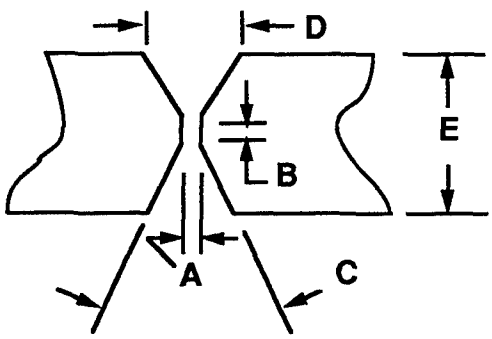
REPORT NO.

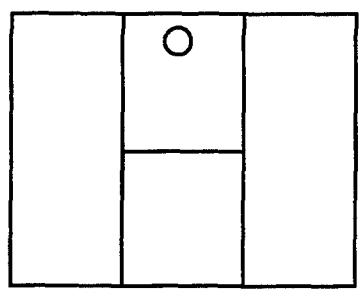
SHEET ____ OF ____

INSPECTION CHECK SHEET

H-PLATE NO. 74

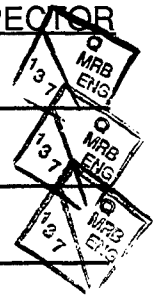
CONTRACT NO. 5T5T000001





A) ROOT GAP .09"
B) ROOT FACE .062"
C) INCLUDED ANGLE 45^{0} + 5^{0}, -0^{0}
D) BEVEL OPENING .57"-.65"
E) PLATE THICKNESS 1.50"

	DATE	INSPECTOR
RIGHT LEG FIT-UP	4-14-92	
LEFT LEG FIT-UP	4-14-92	
CROSS-BAR FIT-UP	4-14-92	



DISCREPENCIES AND/OR DEVIATIONS

DEPARTMENT OF THE ARMY
U. S. ARMY COMBAT SYSTEMS TEST ACTIVITY
ABERDEEN PROVING GROUND, MARYLAND 21005-5059

REPLY TO ATTENTION OF

Advanced Armor Division

Date : June 21, 1994

Manufacturer : General Dynamics
address : 1161 Buckeye Road
Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows :

Firing Record No. : 940669
Plate No. : 74

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.490	75-mm M1002	1194	1204	1"	Pass

Sample no. 74 passed the ballistic requirements of MIL-STD-1946A. The sample sustained a 1" zone cracking on the impact side and no cracking on the opposite side from test impact. The sample passed the radiographic requirements of MIL-STD-1946A performed by USACSTA.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

Richard E. Latham

For JAMES P. FINFERA
Chief, Advanced Projects Division

FORM 1

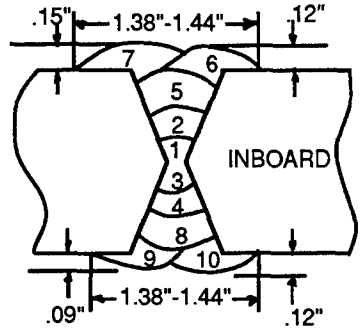
WELD ARMOR DATA

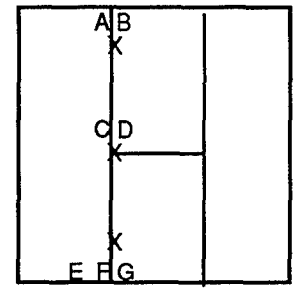
REPORT NO:
SHEET __ OF __

PLATE NO: 106	SUBMITTED BY: GENERAL DYNAMICS
DATE: FEBRUARY 23, 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA ARMOR	
WELDED BY: ED JOHNSON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.

TOP





LEFT LEG

Weld reinforcement (~~has~~) (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC / ROBOTIC (H.C.D.)	
PREHEAT: 300 F MINIMUM	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	300	27.0	450	39" / 2:45	310	310	310
2	.045	S	WB	420	32.0	750	39" / 2:18	300	305	305
3	.045	S	BG	300	27.0	450	39" / 2:47	310	310	310
4	.045	S	WB	420	32.3	750	39" / 2:25	330	345	340
5	.045	S	WB	470	38.5	1000	39" / 2:03	310	310	310
6	.045	S	WB	470	38.5	1000	39" / 2:03	310	345	310
7	.045	S	WB	470	38.5	1000	39" / 2:03	305	310	320
8	.045	S	WB	478	38.3	1000	39" / 2:03	305	310	320
9	.045	S	WB	447	38.3	1000	39" / 2:03	310	310	310
10	.045	S	WB	461	38.3	1000	39" / 2:03	310	320	315
11										
12			NOTE: ROTARY FILE ALL STARTS AND STOPS							
13										
14										

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

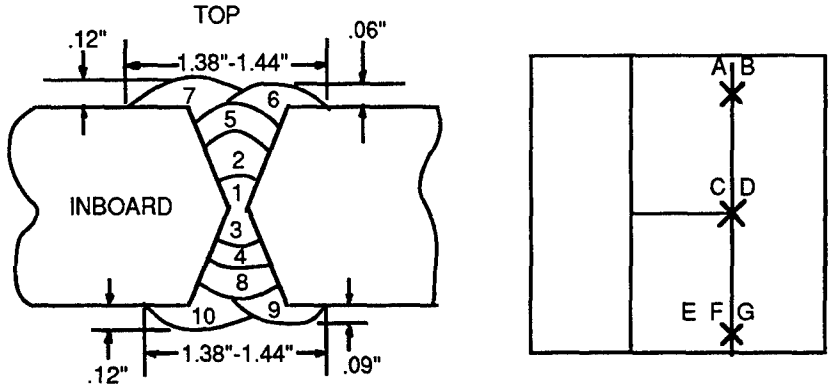
FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET __ OF __

PLATE NO: 106	SUBMITTED BY: GENERAL DYNAMICS
DATE: FEBRUARY 23, 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA	
WELDED BY: ED JOHNSON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.



RIGHT LEG

Weld reinforcement (~~has~~) (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI/ROBOT (H.C.D.)	
PREHEAT: 300 F MINIMUM	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	300	27.0	450	39" / 3:08	310	305	310
2	.045	S	WB	420	32.3	750	39" / 2:18	310	310	305
3	.045	S	BG	300	27.0	450	39" / 3:10	310	315	315
4	.045	S	WB	420	32.3	750	39" / 2:55	300	310	300
5	.045	S	WB	476	38.3	1000	39" / 2:03	305	310	315
6	.045	S	WB	448	38.3	1000	39" / 2:03	300	300	310
7	.045	S	WB	465	38.3	1000	39" / 2:03	315	320	330
8	.045	S	WB	482	38.3	1000	39" / 2:03	305	305	305
9	.045	S	WB	432	38.3	1000	39" / 2:03	315	315	320
10	.045	S	WB	459	38.3	1000	39" / 2:03	320	320	325
11										
12			NOTE:	ROTARY FILE ALL STARTS AND STOPS						
13										
14										

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 1

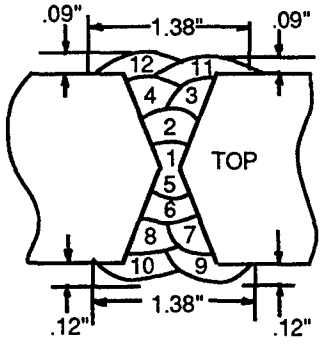
WELD ARMOR DATA

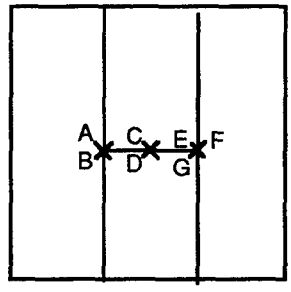
REPORT NO:
SHEET __ OF __

PLATE NO: 106	SUBMITTED BY: GENERAL DYNAMICS
DATE: FEBRUARY 25, 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA ARMOR	
WELDED BY: ED JOHNSON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.

FACE





CROSS-BAR

Weld reinforcement (~~has~~) (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC (H.C.D.)	
PREHEAT: 300 F MINIMUM	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F)		
								A-B	C-D	E-F-G
1	.045	S	WB	320	27.0	450	10.00" / 0:47	305	305	305
2	.045	S	WB	330	28.0	450	11.25" / 1:13	315	315	315
3	.045	S	WB	340	28.0	450	11.75" / 0:48	310	310	310
4	.045	S	WB	340	28.0	450	11.75" / 0:52	305	310	305
5	.045	S	BG	310	27.0	450	10.00" / 0:55	305	305	305
6	.045	S	WB	340	28.0	450	11.25" / 1:10	300	300	300
7	.045	S	WB	330	28.0	450	11.25" / 0:46	300	305	300
8	.045	S	WB	340	28.0	450	11.25" / 0:53	305	310	305
9	.045	S	WB	450	36.5	800	11.75" / 0:50	310	315	310
10	.045	S	WB	440	36.5	800	11.50" / 0:42	300	305	300
11	.045	S	WB	470	36.5	800	12.50" / 0:55	305	310	305
12	.045	S	WB	340	28.0	450	12.75" / 1:00	310	315	310
13										
14										

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 2

ARMOR PLATE DATA

REPORT NO:
SHEET __ OF __

PLATE NO: 106	PLATE "A"	PLATE "B"
MANUFACTURER:	U. S. STEEL	
TYPE:	IMPROVED HARDNESS RHA	
THICKNESS:	1.50"	
HEAT NO:	97840	
LOT NO:		
PROCESS:	QUENCH AND TEMPERED	

CHEMICAL COMPOSITION

	C	MN	SI	P	S	CR	NI	MO	ZR	V	CU
TEST #1	.26	.40	.40	.012	.004	1.47	3.21	.53	.03	.011	.02
TEST #2											

HEAT TREATING DATA

HEAT TREATED BY:

ELECTRODE DATA

TABLE I

SIZE	MANUFACTURER	TRADE NAME	TYPE	CLASS
.045"	Lincoln Electric	LA - 100	Mil- E-23765/2	Mil-100S-1

TABLE II

MANUFACTURER TRADE NAME AND SIZE	CHEMICAL ANALYSIS	C	MN	SI	S	P	CR	NI	MO	CO
LA - 100 / .045"	CORE WIRE	.0455	1.311	.2979	.0057	.0047	.0494	1.784	.4146	.0023
	WELD METAL									
	CORE WIRE									
	WELD METAL									
	CORE WIRE									
	WELD METAL									

TABLE III (AUTOMATIC WELDING)

MANUFACTURER	TRADE NAME	SIZE	FLUX

RADIOGRAPHED BY: LARRY SEAY

RADIOGRAPH SERIAL NO. R #2054

REMARKS: The procedure used in fabricating the crossbar weld **(is)** ~~**(is not)**~~ the same as the procedure used in fabricating the leg welds.

FABRICATOR REPRESENTATIVE	RESIDENCE INSPECTOR OF ORDNANCE
Mark Tussé	

FORM 3

WELD RADIOGRAPHIC REPORT

(1) REPORT NO.

SHEET NO___ OF ___

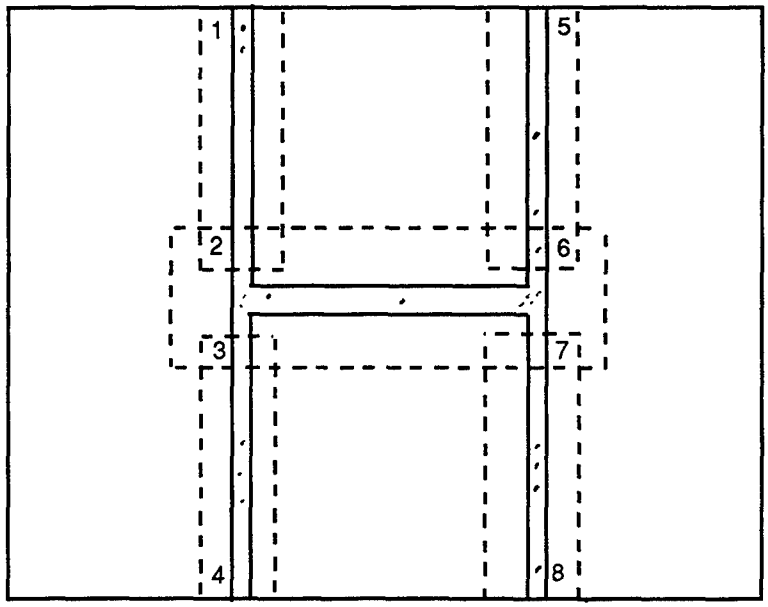
(2) X-RAY SERIAL NO: R #2054

(3) PLATE SUBMITTED BY: GDLS	(4) PLATE NO. HP #106	(5) SPEC. ASTM-E390 STD. II
(6) RADIOGRAPHED BY: GDLS	(7) DATE: 03 MARCH 1994	

(8) PLATE THICKNESS: 1.5"	(9) KV 420 KV	(10) MA 10 MA	(11) TIME 1.5 - 1.9 MIN.	(12) FOCAL DIST. 42"
(13) TYPE OF FILM KODAK 'M'		(14) SCREENS OR FILTERS .010 F & B		

SHOCK TEST PLATE

SHOWING LOCATION OF RADIOGRAPHS AND RESULTS OF TESTS



(15) LEGEND: CRACK; INCOMPLETE FUSION; INCOMPLETE PENETRATION; POROSITY AND SLAG INCLUSIONS; UNDERCUTTING

(16) RESULTS

1-2 SCATTERED POROSITY - STD I

3-4 SCATTERED POROSITY - STD I

5-6 SCATTERED POROSITY - STD I

7-8 SCATTERED POROSITY - STD I

X-BAR SCATTERED POROSITY - STD I

(17) NEGATIVES READ BY: L. M. Seary

(18) GOV'T Q. A. REP. N/R

FORM 4

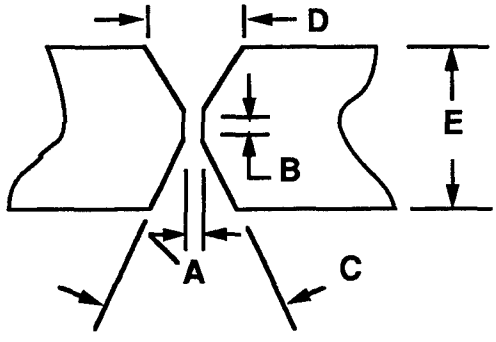
REPORT NO.

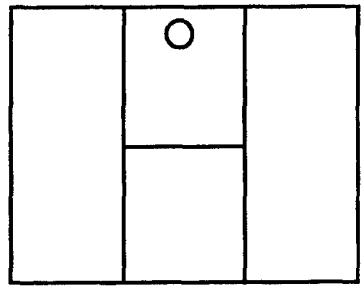
SHEET ____ OF ____

INSPECTION CHECK SHEET

H-PLATE NO. 106

CONTRACT NO. DAAL04-91-C-0040





A) ROOT GAP .09" - .12"
B) ROOT FACE .06"
C) INCLUDED ANGLE 45°
D) BEVEL OPENING .75" - .81"
E) PLATE THICKNESS 1.50"

	DATE	INSPECTOR
RIGHT LEG FIT-UP	2-22-94	
LEFT LEG FIT-UP	2-22-94	
CROSS-BAR FIT-UP	2-22-94	

DISCREPENCIES AND/OR DEVIATIONS

DEPARTMENT OF THE ARMY
U. S. ARMY COMBAT SYSTEMS TEST ACTIVITY
ABERDEEN PROVING GROUND, MARYLAND 21005-5059

REPLY TO
ATTENTION OF

Advanced Armor Division

Date : June 21, 1994

Manufacturer : General Dynamics
address : 1161 Buckeye Road
Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows :

Firing Record No. : 940670
Plate No. : 106

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.494	75-mm M1002	1194	1210	5-1/8"	Pass

Sample no. 106 passed the ballistic requirements of MIL-STD-1946A. The sample sustained no cracking on the impact side and 5-1/8" weld cracking on the opposite side from test impact. The sample passed the radiographic requirements of MIL-STD-1946A performed by USACSTA.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

Richard E. Latham

for JAMES P. FINFERA
Chief, Advanced Projects Division

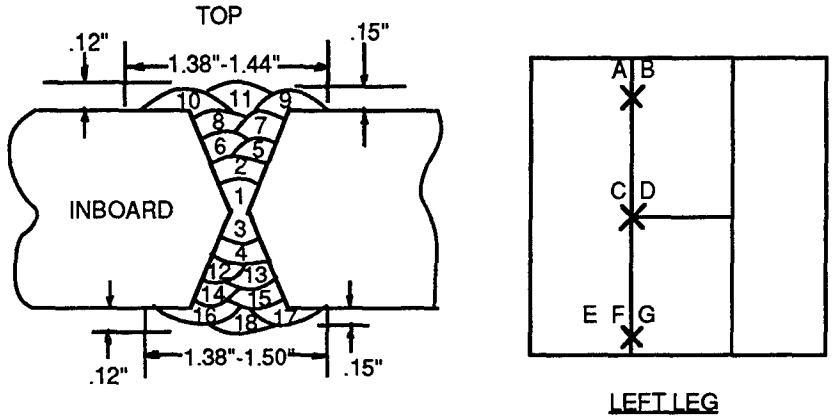
FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET __ OF __

PLATE NO: 107	SUBMITTED BY: GENERAL DYNAMICS
DATE: MARCH 2, 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA	
WELDED BY: ED JOHNSON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.



Weld reinforcement (~~has~~) (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC SPRAY	DEW POINT -88.6 F
PREHEAT: 300 F MINIMUM	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F)		
								A-B	C-D	E-F-G
1	.062	S	WB	340	27.0	200	39.50" / 3:23	305	310	305
2	.062	S	WB	350	28.0	195	39.50" / 4:15	305	310	305
3	.062	S	BG	330	26.5	200	40.00" / 3:44	310	315	310
4	.062	S	WB	350	28.0	195	40.00" / 4:18	315	315	320
5	.062	S	WB	310	27.5	170	40.00" / 2:48	320	320	320
6	.062	S	WB	330	27.5	180	40.00" / 3:25	305	305	305
7	.062	S	WB	330	27.5	170	40.00" / 3:10	310	310	310
8	.062	S	WB	320	27.5	170	40.00" / 3:00	300	305	300
9	.062	S	WB	340	28.0	180	39.00" / 2:50	310	315	310
10	.062	S	WB	340	28.0	180	39.00" / 3:05	310	315	305
11	.062	S	WB	330	28.0	180	39.00" / 3:00	305	320	300
12	.062	S	WB	320	27.5	180	39.50" / 2:57	310	320	320
13	.062	S	WB	320	27.0	180	39.50" / 3:16	300	305	300
14	.062	S	WB	330	27.0	180	39.50" / 2:55	320	325	330
15	.062	S	WB	330	27.0	180	39.50" / 3:00	330	330	330
16	.062	S	WB	330	28.0	180	39.50" / 3:00	310	310	310
17	.062	S	WB	330	28.0	180	39.50" / 3:00	310	310	310
18	.062	S	WB	330	27.5	180	39.50" / 3:00	305	310	310

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

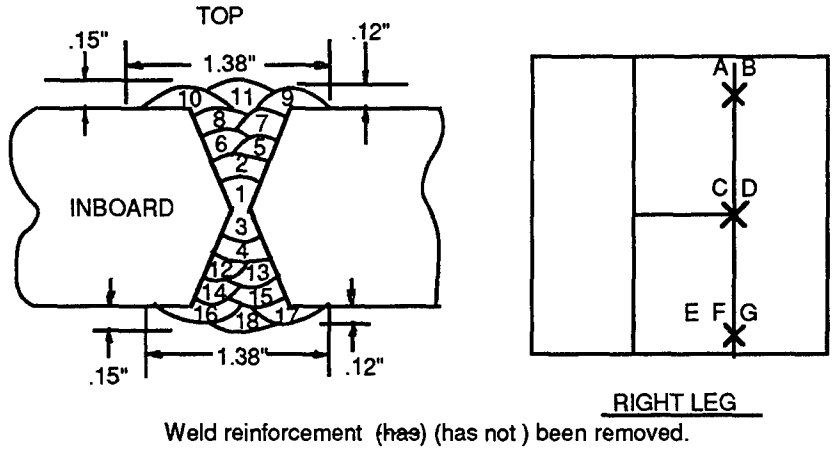
FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET __ OF __

PLATE NO: 107	SUBMITTED BY: GENERAL DYNAMICS
DATE: MARCH 2, 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA	
WELDED BY: ED JOHNSON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.



RIGHT LEG

Weld reinforcement (~~has~~) (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC SPRAY	DEW POINT -88.6 F
PREHEAT: 300 F MINIMUM	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F)		
								A-B	C-D	E-F-G
1	.062	S	WB	330	26.5	200	39.50" / 4:55	310	310	310
2	.062	S	WB	350	28.0	195	40.50" / 4:35	310	315	320
3	.062	S	BG	340	26.5	200	40.00" / 3:53	325	330	320
4	.062	S	WB	350	28.0	195	40.00" / 4:15	310	330	330
5	.062	S	WB	320	27.5	180	40.00" / 2:30	310	305	305
6	.062	S	WB	330	27.5	180	40.00" / 3:15	335	330	330
7	.062	S	WB	330	27.5	170	40.00" / 2:13	315	305	305
8	.062	S	WB	335	27.5	180	40.00" / 3:00	320	320	320
9	.062	S	WB	330	28.0	180	39.00" / 3:05	325	330	325
10	.062	S	WB	340	28.0	180	39.00" / 3:00	310	320	315
11	.062	S	WB	335	28.0	180	39.00" / 3:00	305	310	305
12	.062	S	WB	320	27.0	180	39.50" / 2:33	350	350	350
13	.062	S	WB	320	27.0	180	39.50" / 3:00	350	350	350
14	.062	S	WB	320	27.0	180	39.50" / 2:53	330	340	330
15	.062	S	WB	330	27.5	180	39.50" / 2:45	325	330	330
16	.062	S	WB	330	28.0	180	39.50" / 2:45	330	330	330
17	.062	S	WB	330	28.0	180	39.50" / 2:45	320	325	330
18	.062	S	WB	330	27.5	185	39.50" / 2:45	320	320	320

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

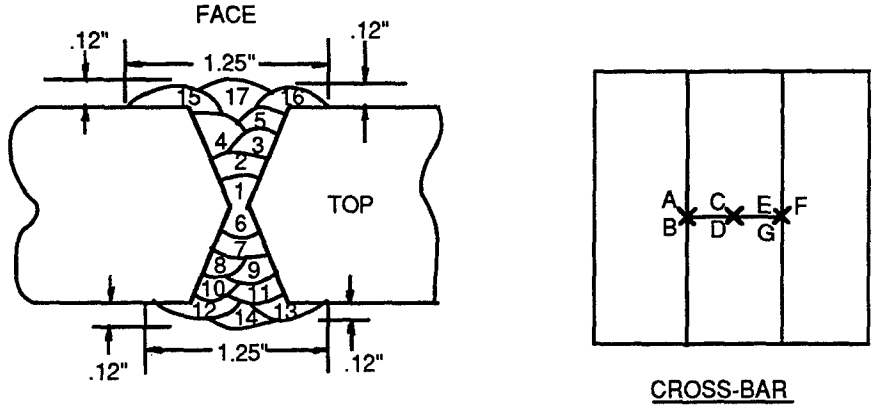
FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET __ OF __

PLATE NO: 107	SUBMITTED BY: GENERAL DYNAMICS
DATE: MARCH 7, 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.5"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO: DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA	
WELDED BY: ED JOHNSON	
OBJECT: BALLISTIC SHOCK TEST	

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.



Weld reinforcement (~~has~~) (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX
WELDING: G.M.A.W. SEMI-AUTOMATIC SPRAY	DEW POINT -88.6 F
PREHEAT: 300 F MINIMUM	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F)		
								A-B	C-D	E-F-G
1	.062	S	WB	330	26.5	200	9.50" / 0:46	310	310	310
2	.062	S	WB	350	28.0	195	10.00" / 1:10	320	310	320
3	.062	S	WB	330	27.5	190	11.00" / 0:53	300	305	300
4	.062	S	WB	330	27.5	190	11.00" / 0:57	330	330	330
5	.062	S	WB	340	27.5	190	11.00" / 0:42	330	335	330
6	.062	S	BG	320	26.5	200	9.50" / 1:06	330	330	330
7	.062	S	WB	340	28.0	200	10.50" / 1:26	300	310	300
8	.062	S	WB	330	27.5	190	11.25" / 1:05	300	310	300
9	.062	S	WB	340	27.5	190	11.50" / 1:10	310	320	325
10	.062	S	WB	340	27.5	190	12.00" / 1:00	315	320	320
11	.062	S	WB	340	27.5	190	12.00" / 0:50	305	315	305
12	.062	S	WB	330	27.5	180	12.00" / 1:03	325	330	325
13	.062	S	WB	330	27.5	180	12.00" / 1:00	325	330	325
14	.062	S	WB	340	28.0	180	12.00" / 1:00	310	315	315
15	.062	S	WB	340	27.5	180	12.00" / 1:00	340	340	340
16	.062	S	WB	340	27.5	180	12.00" / 1:00	330	335	330
17	.062	S	WB	340	28.0	180	12.00" / 1:00	310	315	310
18				ROTARY FILE ALL STARTS AND STOPS						

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 2

ARMOR PLATE DATA

REPORT NO:

SHEET 4 OF 6

PLATE NO: 107	PLATE "A"	PLATE "B"
MANUFACTURER:	U. S. STEEL	
TYPE:	IMPROVED HARDNESS RHA	
THICKNESS:	1.50"	
HEAT NO:	97840	
LOT NO:		
PROCESS:	QUENCH AND TEMPERED	

CHEMICAL COMPOSITION

	C	MN	SI	P	S	CR	NI	MO	ZR	V	CU
TEST #1	.26	.40	.40	.012	.004	1.47	3.21	.53	.03	.011	.02
TEST #2											

HEAT TREATING DATA

HEAT TREATED BY:

ELECTRODE DATA

TABLE I

SIZE	MANUFACTURER	TRADE NAME	TYPE	CLASS
.062"	Lincoln Electric	LA - 100	Mil- E-23765/2	Mil-100S-1

TABLE II

MANUFACTURER TRADE NAME AND SIZE	CHEMICAL ANALYSIS	C	MN	SI	S	P	CR	NI	MO	CO
LA - 100 / .062"	CORE WIRE	.049	1.68	.48	.003	.007	.05	1.94	.45	
	WELD METAL									
	CORE WIRE									
	WELD METAL									
	CORE WIRE									
	WELD METAL									

TABLE III (AUTOMATIC WELDING)

MANUFACTURER	TRADE NAME	SIZE	FLUX

RADIOGRAPHED BY: LARRY SEAY

RADIOGRAPH SERIAL NO. R #2052

REMARKS: The procedure used in fabricating the crossbar weld **(is)** ~~**(is not)**~~ the same as the procedure used in fabricating the leg welds.

FABRICATOR REPRESENTATIVE	RESIDENCE INSPECTOR OF ORDNANCE
Mark Nesi	

FORM 3

WELD RADIOGRAPHIC REPORT

(1) REPORT NO.

SHEET NO___ OF ___

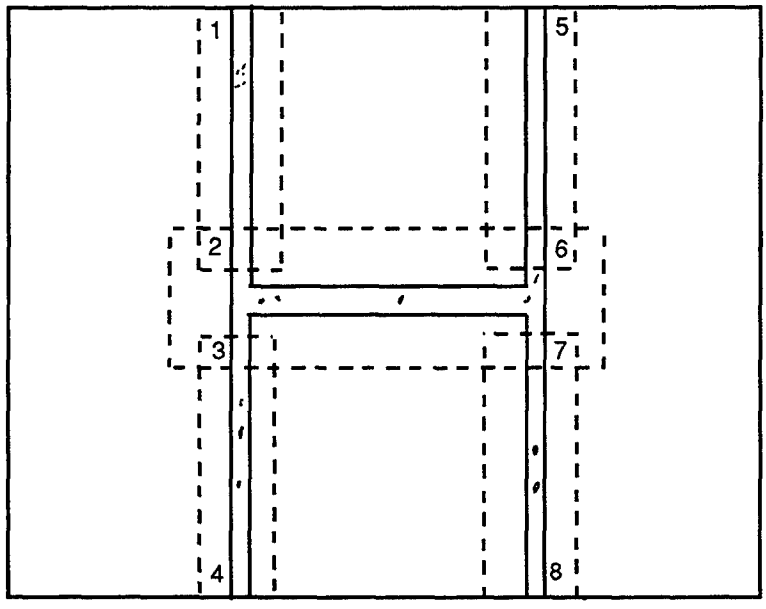
(2) X-RAY SERIAL NO: R #2052

(3) PLATE SUBMITTED BY: GDLS	(4) PLATE NO. HP #107	(5) SPEC. ASTM-E390 STD. II
(6) RADIOGRAPHED BY: GDLS	(7) DATE: 21 APRIL 1994	

(8) PLATE THICKNESS: 1.5"	(9) KV 420 KV	(10) MA 10 MA	(11) TIME 1.6 - 2.0 MIN.	(12) FOCAL DIST. 42"
(13) TYPE OF FILM KODAK 'M'		(14) SCREENS OR FILTERS .010 F & B		

SHOCK TEST PLATE

SHOWING LOCATION OF RADIOGRAPHS AND RESULTS OF TESTS



(15) LEGEND: CRACK; INCOMPLETE FUSION; INCOMPLETE PENETRATION; POROSITY AND SLAG INCLUSIONS; UNDERCUTTING

(16) RESULTS

1-2 SCATTERED POROSITY - STD I

3-4 SCATTERED POROSITY - STD I

5-6 SOUND

7-8 SCATTERED POROSITY - STD I

X-BAR SCATTERED POROSITY - STD I

(17) NEGATIVES READ BY: L. N. Seay

(18) GOV'T Q. A. REP. N/R

FORM 4

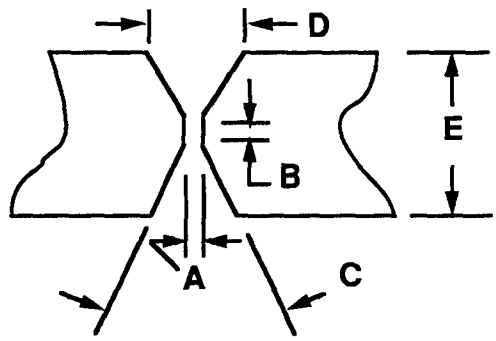
REPORT NO.

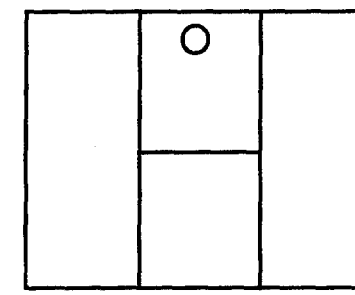
SHEET ___ OF ___

INSPECTION CHECK SHEET

H-PLATE NO. 107

CONTRACT NO. DAAL04-91-C-0040





A) ROOT GAP .09" - .12"
B) ROOT FACE .06"
C) INCLUDED ANGLE 45°
D) BEVEL OPENING .69" - .75"
E) PLATE THICKNESS 1.50"

	DATE	INSPECTOR
RIGHT LEG FIT-UP	3-1-94	
LEFT LEG FIT-UP	3-1-94	
CROSS-BAR FIT-UP	3-1-94	

DISCREPENCIES AND/OR DEVIATIONS

Spec 1

DEPARTMENT OF THE ARMY
U. S. ARMY COMBAT SYSTEMS TEST ACTIVITY
ABERDEEN PROVING GROUND, MARYLAND 21005-5059

REPLY TO
ATTENTION OF

Advanced Armor Division

Date : June 21, 1994

Manufacturer : General Dynamics
address : 1161 Buckeye Road
Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows :

Firing Record No. : 940671
Plate No. : 107

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.499	75-mm M1002	1200	1205	none	Pass

Sample no. 107 passed the ballistic requirements of MIL-STD-1946A. The sample sustained no cracking on the impact side and no cracking on the opposite side from test impact. The sample passed the radiographic requirements of MIL-STD-1946A performed by USACSTA.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

Richard E. Latham

For JAMES P. FINFERA
Chief, Advanced Projects Division

√FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET __ OF __

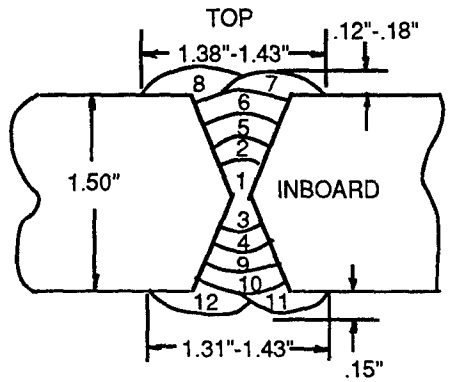
PLATE NO: 108	SUBMITTED BY: GENERAL DYNAMICS
DATE: APRIL 4 , 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.50"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560	CONTRACT NO: DAAL04-91-C-0040

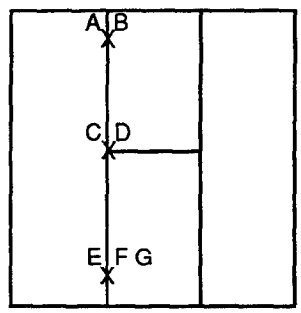
ORDNANCE MATERIAL CONCERNED: IMPROVED HARDNESS RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





LEFT LEG

Weld reinforcement ~~(has)~~ (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GROUND	BACKING TAPE: CERAMIC
POSITION OF WELDING VERTICAL	SHIELDING GAS: 95% AR - 5% OX
WELDING: GMAW SEMI-AUTOMATIC - PULSE	DEW POINT : -86.1 F
PREHEAT: 300 F	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	135	20.3	230	38.50" / 8:05	310	315	310
2	.045	W	WB	130	19.1	195	38.50" / 7:10	315	315	320
3	.045	S	BG	125	19.8	200	38.50" / 6:30	320	315	310
4	.045	W	WB	130	19.1	195	38.50" / 8:00	345	345	340
5	.045	W	WB	135	19.8	195	38.50" / 9:17	315	320	325
6	.045	W	WB	135	19.8	195	38.50" / 12:33	325	325	325
7	.045	W	WB	110	18.5	140	38.50" / 14:45	325	330	335
8	.045	W	WB	110	18.6	140	38.50" / 14:05	325	325	330
9	.045	W	WB	135	19.6	195	38.50" / 9:07	325	325	320
10	.045	W	WB	140	19.8	200	38.50" / 13:48	310	320	320
11	.045	W	WB	110	19.3	140	38.50" / 12:13	325	315	310
12	.045	W	WB	110	19.3	140	38.50" / 13:00	330	335	330
13										
14										
15										
16										

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

BACKGRIND

√FORM 1

WELD ARMOR DATA

REPORT NO:
SHEET 2 OF 6

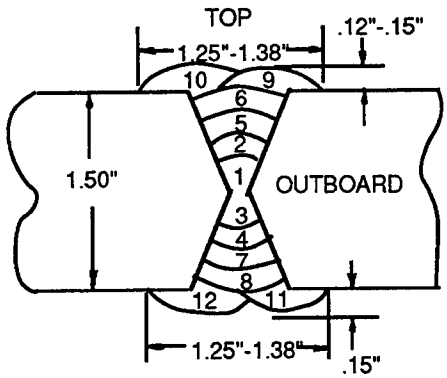
PLATE NO: 108	SUBMITTED BY: GENERAL DYNAMICS
DATE: MARCH 31 , 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.50"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560	CONTRACT NO: DAAL04-91-C-0040

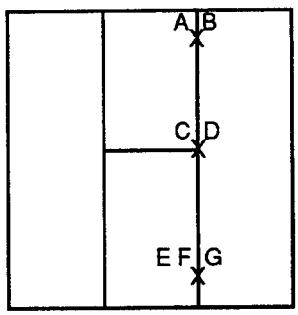
ORDNANCE MATERIAL CONCERNED: IMPROVED HARDNESS RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





RIGHT LEG

Weld reinforcement ~~(has)~~ (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GROUND	BACKING TAPE: CERAMIC
POSITION OF WELDING VERTICAL	SHIELDING GAS: 95% AR - 5% OX
WELDING: GMAW SEMI-AUTOMATIC - PULSE	DEW POINT : -86.1 F
PREHEAT: 300 F	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	145	20.8	230	38.50" / 5:49	310	310	310
2	.045	W	WB	135	20.8	195	38.50" / 8:35	320	325	320
3	.045	S	BG	120	20.6	200	38.50" / 6:53	320	325	320
4	.045	W	WB	135	20.8	195	38.50" / 10:00	325	330	325
5	.045	W	WB	130	20.8	195	38.50" / 9:45	310	310	305
6	.045	W	WB	135	20.3	195	38.50" / 10:07	310	315	305
7	.045	W	WB	130	19.8	195	38.50" / 9:25	320	315	310
8	.045	W	WB	130	19.8	195	38.50" / 11:15	315	320	325
9	.045	W	WB	110	19.1	140	38.50" / 12:49	325	325	325
10	.045	W	WB	115	19.3	140	38.50" / 12:46	345	340	330
11	.045	W	WB	115	19.3	140	38.50" / 12:41	345	340	340
12	.045	W	WB	115	19.3	140	38.50" / 14:05	330	340	345
13										
14										
15										
16										

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

BACKGRIND

VFORM 1

WELD ARMOR DATA

REPORT NO:
SHEET __ OF __

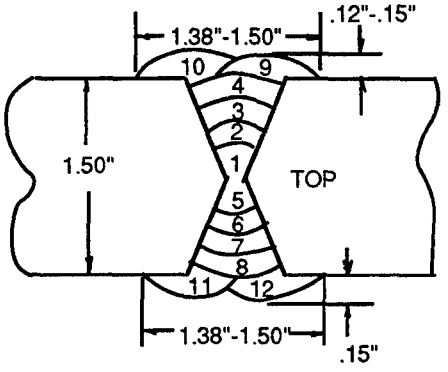
PLATE NO: 108	SUBMITTED BY: GENERAL DYNAMICS
DATE: APRIL 8 , 1994	LAND SYSTEMS DIVISION
TYPE: 3	1161 BUCKEYE ROAD
THICKNESS: 1.50"	LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560	CONTRACT NO: DAAL04-91-C-0040

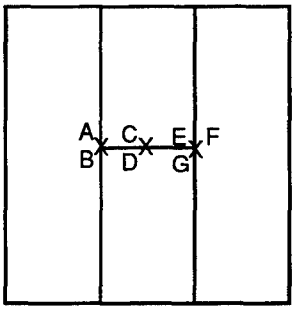
ORDNANCE MATERIAL CONCERNED: IMPROVED HARDNESS RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





CROSS-BAR

Weld reinforcement ~~(has)~~ (has not) been removed.

WELDING DATA

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GROUND	BACKING TAPE: CERAMIC
POSITION OF WELDING VERTICAL	SHIELDING GAS: 95% AR - 5% OX
WELDING: GMAW SEMI-AUTOMATIC - PULSE	DEW POINT : -86.1 F
PREHEAT: 300 F	POSTHEAT: NONE
PEENING: NONE	BUTTERING: NONE

PASS	ELEC SIZE	TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH	INTERPASS TEMP (°F) A-B	C-D	E-F-G
1	.045	S	WB	135	19.8	230	8.50" / 1:18	310	310	310
2	.045	W	WB	130	19.1	195	9.00" / 1:52	345	350	345
3	.045	W	WB	140	19.8	195	10.00" / 2:50	305	310	305
4	.045	W	WB	135	19.8	195	11.00" / 3:53	305	305	305
5	.045	S	BG	130	19.8	200	9.00" / 1:37	310	315	310
6	.045	W	WB	135	19.8	195	9.50" / 2:37	330	335	330
7	.045	W	WB	140	19.6	195	9.75" / 2:30	320	330	320
8	.045	W	WB	140	19.6	195	11.00" / 3:26	305	310	305
9	.045	W	WB	110	19.3	140	11.75" / 4:10	330	330	330
10	.045	W	WB	115	19.5	140	12.00" / 4:43	335	330	335
11	.045	W	WB	110	19.6	140	12.00" / 4:35	335	335	330
12	.045	W	WB	110	19.4	140	12.00" / 4:25	325	330	330
13										
14				ROTARY FILE AND GRIND ALL STARTS AND STOPS						
15										
16										

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 2

ARMOR PLATE DATA

REPORT NO:
SHEET __ OF __

PLATE NO: 108	PLATE "A"	PLATE "B"
MANUFACTURER:	U. S. STEEL	
TYPE:	IMPROVED HARDNESS RHA	
THICKNESS:	1.50"	
HEAT NO:	97840	
LOT NO:		
PROCESS:	QUENCH AND TEMPERED	

CHEMICAL COMPOSITION

	C	MN	SI	P	S	CR	NI	MO	ZR	V	CU
TEST #1	.26	.40	.40	.012	.004	1.47	3.21	.53	.03	.011	.02
TEST #2											

HEAT TREATING DATA

HEAT TREATED BY:

ELECTRODE DATA

TABLE I

SIZE	MANUFACTURER	TRADE NAME	TYPE	CLASS
.045"	Lincoln Electric	LA - 100	Mil- E-23765/2	Mil-100S-1

TABLE II

MANUFACTURER TRADE NAME AND SIZE	CHEMICAL ANALYSIS	C	MN	SI	S	P	CR	NI	MO	CO
LA - 100 / .045"	CORE WIRE	.0455	1.311	.2979	.0057	.0047	.0494	1.784	.4146	.0023
	WELD METAL									
	CORE WIRE									
	WELD METAL									
	CORE WIRE									
	WELD METAL									

TABLE III (AUTOMATIC WELDING)

MANUFACTURER	TRADE NAME	SIZE	FLUX

RADIOGRAPHED BY: LARRY SEAY

RADIOGRAPH SERIAL NO. R #2053

REMARKS: The procedure used in fabricating the crossbar weld **(is)** ~~**(is not)**~~ the same as the procedure used in fabricating the leg welds.

FABRICATOR REPRESENTATIVE	RESIDENCE INSPECTOR OF ORDNANCE
Mark Niese	

FORM 3

WELD RADIOGRAPHIC REPORT

(1) REPORT NO.

SHEET NO___ OF___

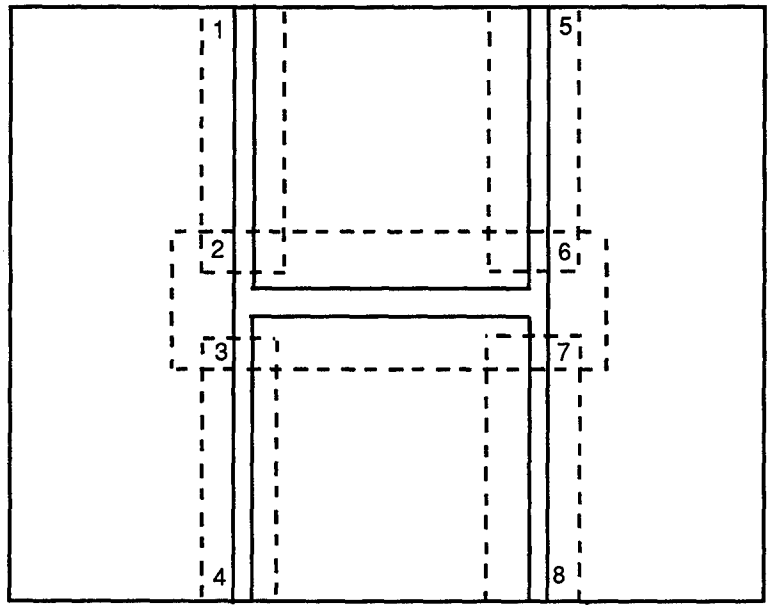
(2) X-RAY SERIAL NO: R #2053

(3) PLATE SUBMITTED BY: GDLS	(4) PLATE NO. HP #108	(5) SPEC. ASTM-E390 STD. II
(6) RADIOGRAPHED BY: GDLS	(7) DATE: 15 APRIL 1994	

(8) PLATE THICKNESS: 1.5"	(9) KV 420 KV	(10) MA 10 MA	(11) TIME 1.6 - 2.0 MIN.	(12) FOCAL DIST. 42"
(13) TYPE OF FILM KODAK 'M'		(14) SCREENS OR FILTERS .010 F & B		

SHOCK TEST PLATE

SHOWING LOCATION OF RADIOGRAPHS AND RESULTS OF TESTS



(15) LEGEND: CRACK; INCOMPLETE FUSION; INCOMPLETE PENETRATION; POROSITY AND SLAG INCLUSIONS; UNDERCUTTING

(16) RESULTS

1-2 SCATTERED POROSITY - STD I

3-4 SCATTERED POROSITY - STD I

5-6 SCATTERED POROSITY - STD I

7-8 SOUND

X-BAR SCATTERED POROSITY - STD I

(17) NEGATIVES READ BY: L. M. Seay (18) GOV'T Q. A. REP.

FORM 4

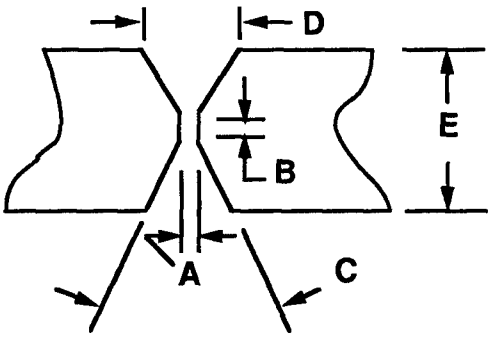
REPORT NO.

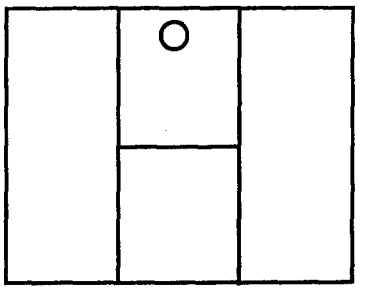
SHEET ____ OF ____

INSPECTION CHECK SHEET

H-PLATE NO. 108

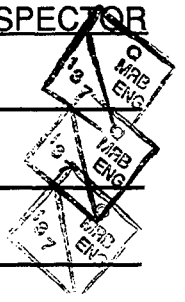
CONTRACT NO. DAAL04-91-C-0040





A) ROOT GAP .09" - .12"
B) ROOT FACE .06"
C) INCLUDED ANGLE 45°
D) BEVEL OPENING .75" - .81"
E) PLATE THICKNESS 1.50"

	DATE	INSPECTOR
RIGHT LEG FIT-UP	3-30-94	
LEFT LEG FIT-UP	3-30-94	
CROSS-BAR FIT-UP	3-30-94	



DISCREPENCIES AND/OR DEVIATIONS

Pulse

DEPARTMENT OF THE ARMY
U. S. ARMY COMBAT SYSTEMS TEST ACTIVITY
ABERDEEN PROVING GROUND, MARYLAND 21005-5059

REPLY TO
ATTENTION OF

Advanced Armor Division

Date : June 21, 1994

Manufacturer : General Dynamics
address : 1161 Buckeye Road
Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows :

Firing Record No. : 940672
Plate No. : 108

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.491	75-mm M1002	1194	1204	1-1/2"	Pass
2	RHA	1.491	75-mm M1002	1194	1206	9-1/2"	Pass

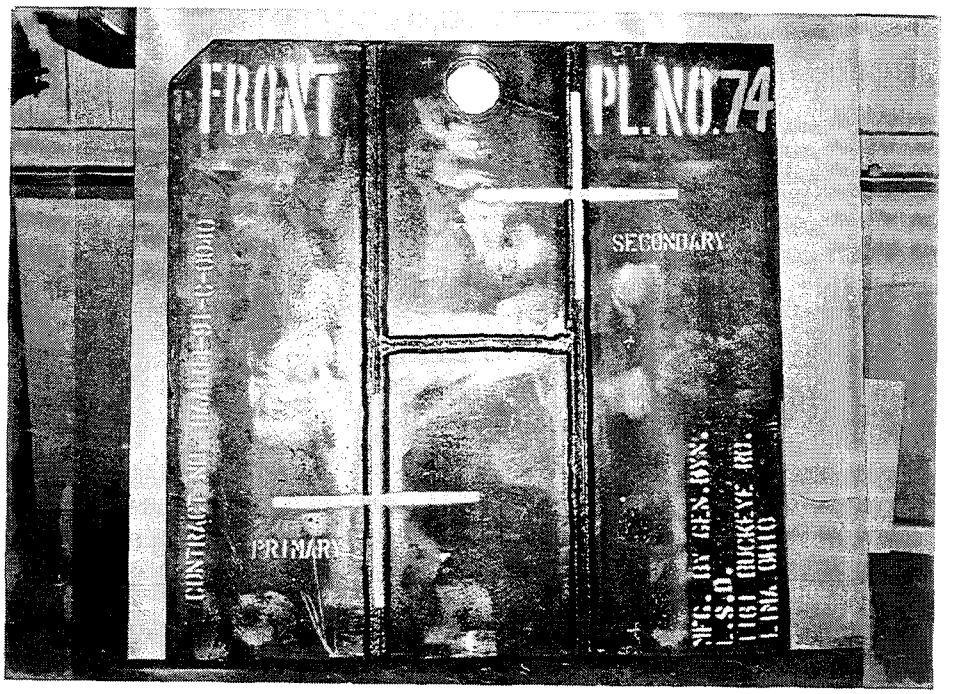
Sample no. 108 passed the ballistic requirements of MIL-STD-1946A. The sample sustained 1-1/2" zone cracking on the impact side and no cracking on the opposite side of impact No 1. Impact No 2 sustained a 2-3/4" zone cracking on the impact side and 6-3/4" weld cracking on the opposite side of impact 2.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

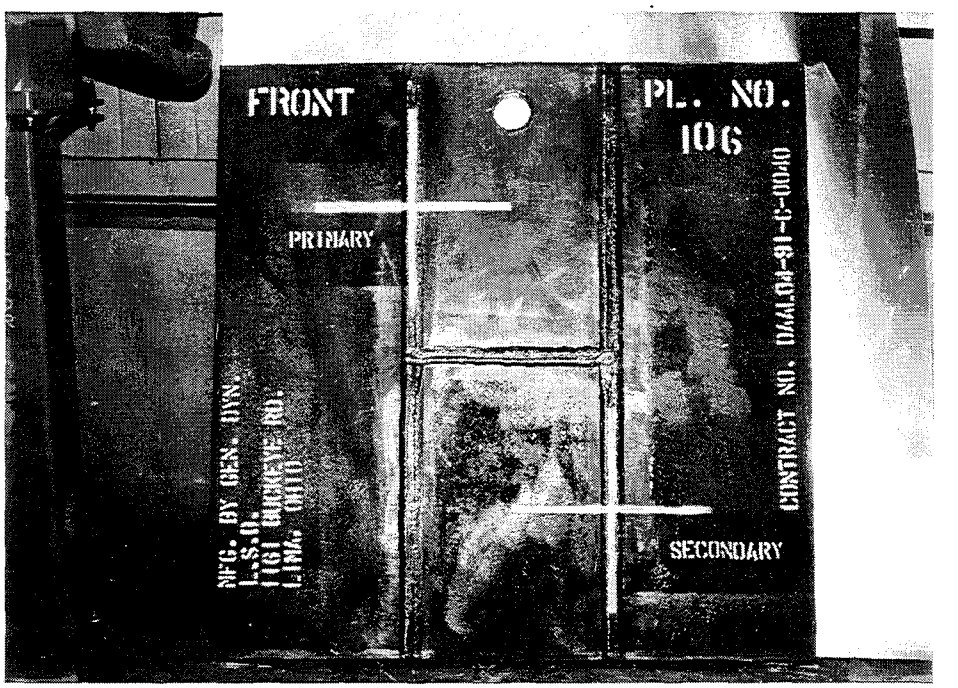
Richard E. Latham

for JAMES P. FINFERA
Chief, Advanced Projects Division

ATTACHMENT 8 - H-PLATE DATA SHEET

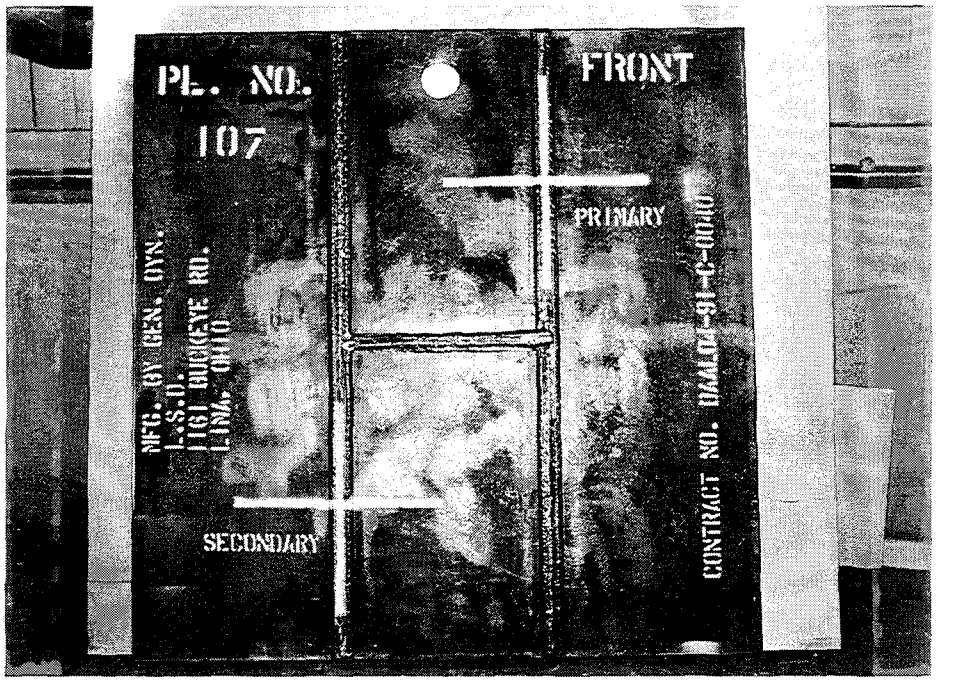


BASE METAL	RHA
H-PLATE NO.	74
WELD PROCESS	HIGH CURRENT DENSITY

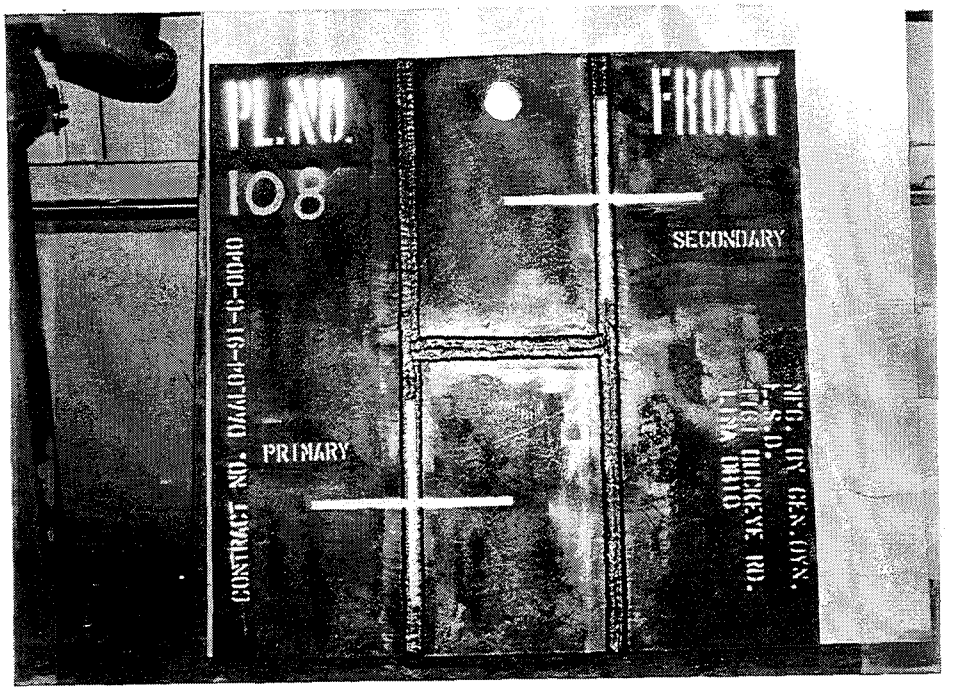


BASE METAL	IMPROVED HARDNESS RHA
H-PLATE NO.	106
WELD PROCESS	HIGH CURRENT DENSITY

ATTACHMENT 8 - H-PLATE DATA SHEET



BASE METAL	IMPROVED HARDNESS RHA
H-PLATE NO.	107
WELD PROCESS	GMAW - SPRAY



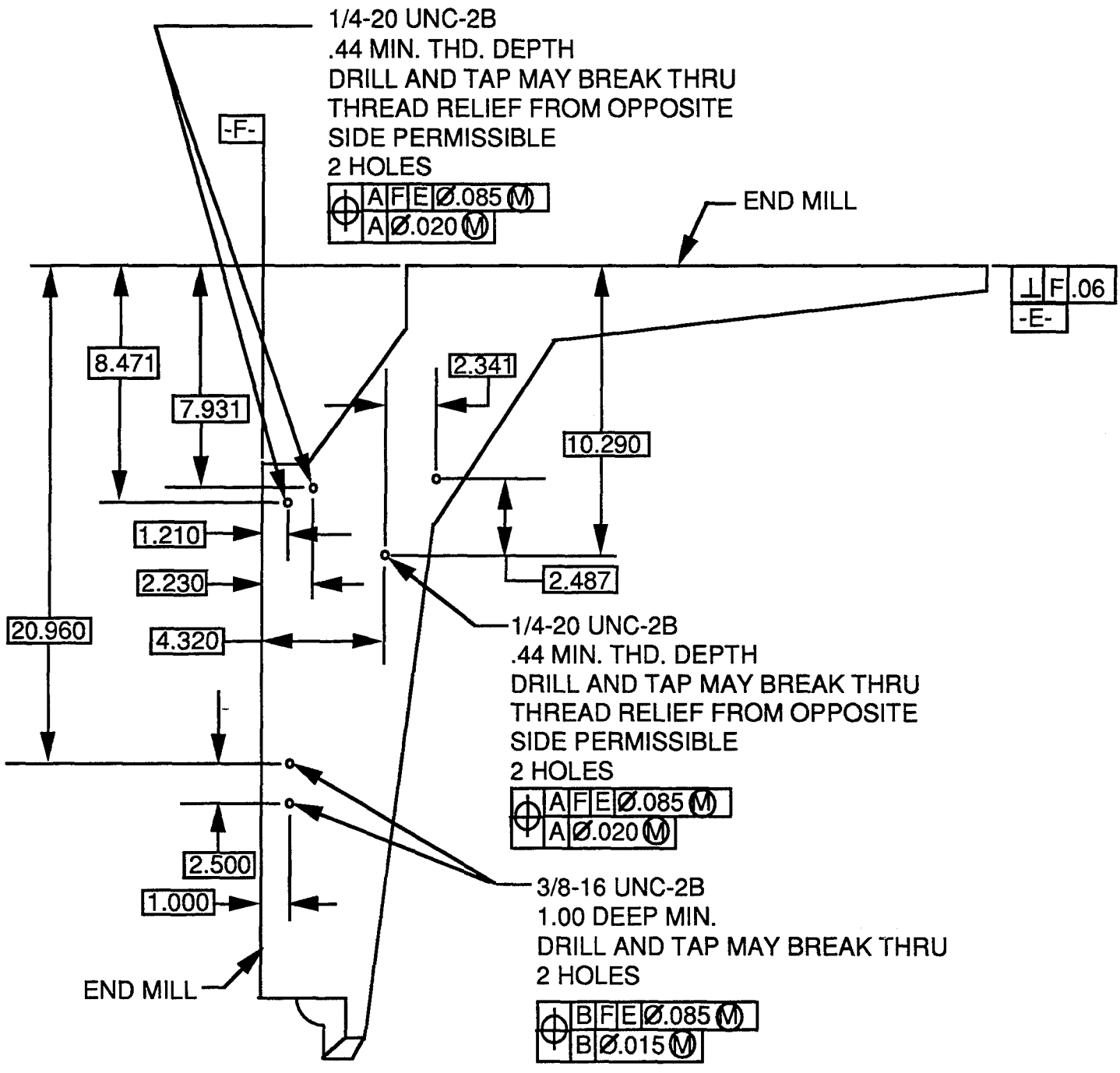
BASE METAL	IMPROVED HARDNESS RHA
H-PLATE NO.	108
WELD PROCESS	GMAW - SPRAY (PULSE)

ATTACHMENT 9

MACHINABILITY DATA SHEETS

GENERAL DYNAMICS
LAND SYSTEMS DIVISION

IMPROVED RHA MACHINABILITY DATA SHEET
P/N - 9377636 - 1 MD PLATE CONFIGURATION



AMMO DOOR SUPPORT PLATE

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	SPOT DRILL
MANUFACTURER	CLEVELAND TWIST DRILL
OPERATION DESCRIPTION	SPOT DRILL 6 PLACES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	400	IPM	2.5
DIA	0.50"	TEETH	

OBSERVATIONS:

THE SPOT DRILL OPERATION PERFORMED SATISFACTORY.

NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED

DURING THE OPERATION.

CONCLUSIONS:

THE SPOT DRILL OPERATION CAN BE PERFORMED USING

THE EXISTING TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 9377636 - 1 MD (6 PLATES)

TOOL DESCRIPTION: 1/4 - 20 UNC TAP

MANUFACTURER:

OPERATION DESCRIPTION: TAP 4 HOLES/PLATE - 2 FLUTE PLUG

TIME IN CUT (MIN):

HP		COOLANT	
SFM		CL	
RPM	300	IPM	
DIA	1/4"	TEETH	

OBSERVATIONS:

NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE TAPPING OPERATION. THE TAPPED HOLES WERE TESTED WITH A THREAD GAGE AND WERE ACCEPTED.

CONCLUSIONS:

THE 1/4 - 20 UNC TAPPING CAN BE PERFORMED SATISFACTORY WITH THE CURRENT TOOLING. TOOLING LIFE MAY BE SHORTENED DUE TO THE INCREASED HARDNESS.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	9/32" DRILL
MANUFACTURER	CLEVELAND TWIST DRILL
OPERATION DESCRIPTION	DRILL - 4 HOLES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	450	IPM	1.4
DIA	9/32"	TEETH	

OBSERVATIONS:

THE DRILL STARTED 'DULLING' ON THE THIRD HOLE OF EACH PLATE EXHIBITING EXCESSIVE WEAR ON THE DRILL. THE DRILL WAS BACKED OFF AND REPLACED. A TOTAL OF THREE DRILLS WERE USED TO COMPLETE THE OPERATION.

CONCLUSIONS:

A DIFFERENT ALLOY DRILL BIT WOULD NEED TO BE USED. THE FEED RATES AND SPEED COULD ALSO BE MODIFIED, BUT FURTHER TESTING WOULD BE REQUIRED.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	DRILL
MANUFACTURER	CLEVELAND TWIST DRILL
OPERATION DESCRIPTION	DRILLING - 4 HOLES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	470	IPM	1.5
DIA	.201"	TEETH	

OBSERVATIONS:

THE DRILLING OPERATION PERFORMED SATISFACTORY WITH NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP NOTED DURING THE OPERATION. THE TOOL LIFE MAY BE SHORTENED DUE TO THE INCREASED HARDNESS.

CONCLUSIONS:

THE DRILLING OPERATION CAN BE PERFORMED WITH THE CURRENT TOOLING SUPPLIED AT LATP WITH THE GIVEN FEED AND TRAVEL RATES. A DIFFERENT TOOL ALLOY MAY INCREASE THE TOOL LIFE.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 9377636 - 1 MD (6 PLATES)

TOOL DESCRIPTION: 3/8 - 16UNC TAP

MANUFACTURER:

OPERATION DESCRIPTION: TAP 2 HOLES/PLATE

TIME IN CUT (MIN)			
HP		COOLANT	
SFM		CL	
RPM	200	IPM	
DIA	3/8"	TEETH	

OBSERVATIONS:

NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE TAPPING OPERATION. THE TAPPED HOLES WERE TESTED WITH A THREAD GAGE AND WERE ACCEPTED.

CONCLUSIONS:

THE 3/8 - 16 UNC TAPPING CAN BE PERFORMED SATISFACTORY WITH THE CURRENT TOOLING. TOOL LIFE MAY BE SHORTENED DUE TO THE INCREASED HARDNESS.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	DRILLING
MANUFACTURER	CLEVELAND TWIST DRILL
OPERATION DESCRIPTION	DRILL (2 HOLES/PLATE)

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	400	IPM	2.0
DIA	5/16"	TEETH	

OBSERVATIONS:

THE DRILLING OPERATION PERFORMED SATISFACTORY.
NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED
DURING THE OPERATION.

CONCLUSIONS:

THE 5/16" DRILLING OPERATION CAN BE PERFORMED WITH THE
CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 9377636 - 1 MD (6 PLATES)

TOOL DESCRIPTION: 3.935" MILL

MANUFACTURER: SECO

OPERATION DESCRIPTION: EDGE MILL - 2 EDGES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	500	IPM	25
DIA	3.935"	TEETH	8 FLUTE

OBSERVATIONS:

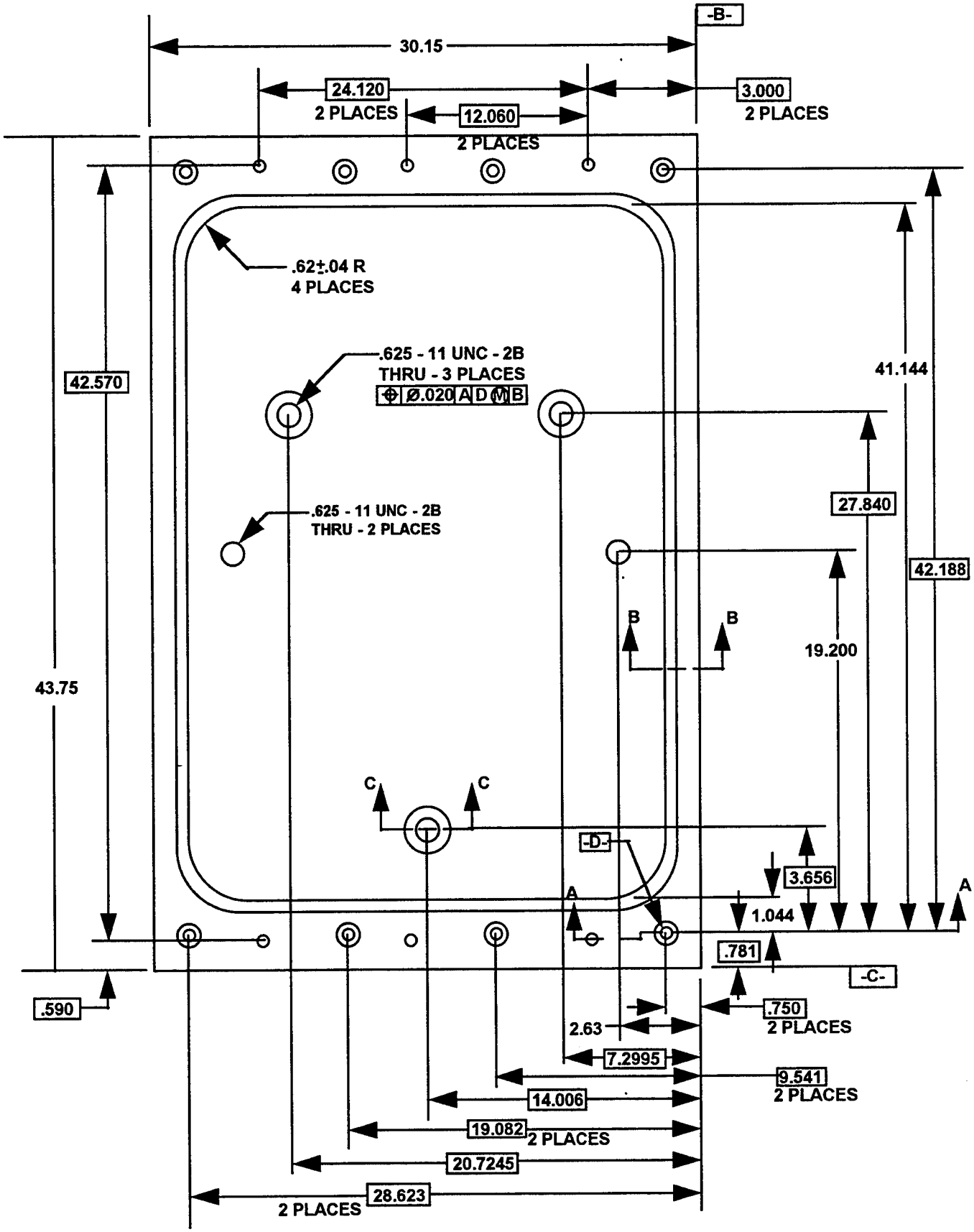
THE EDGE MILL OPERATION PERFORMED SATISFACTORY.

NO EXCESSIVE TOOL WEAR WAS NOTED AFTER THE MACHINING OPERATION.

CONCLUSIONS:

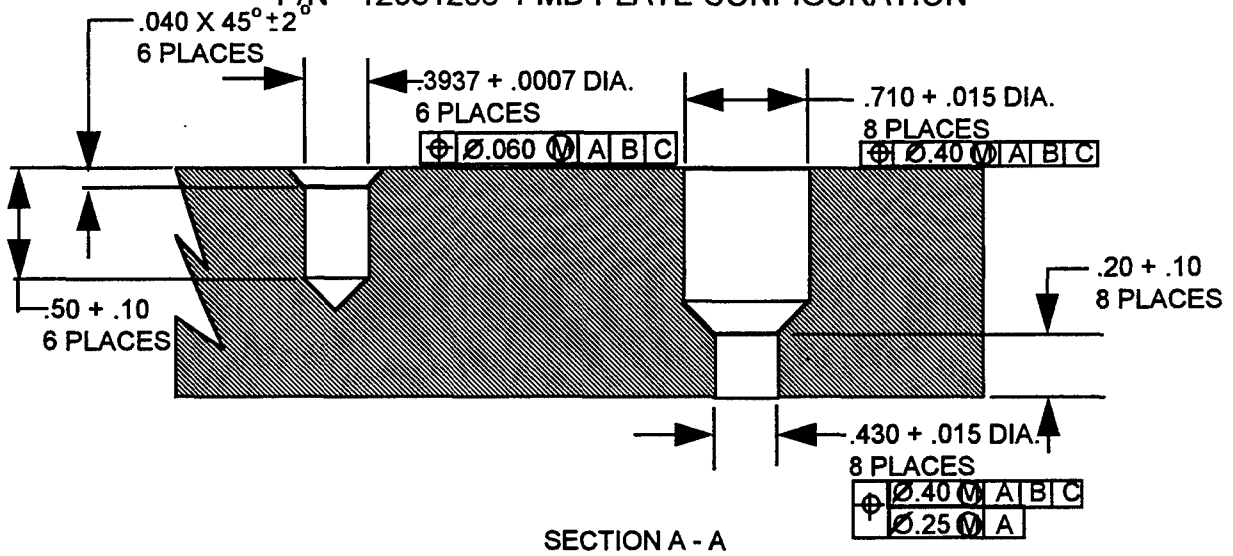
THE EDGE MILL OPERATION CAN BE PERFORMED USING THE EXISTING TOOLING ON THE RHA MATERIAL.

IMPROVED HARDNESS RHA MACHINABILITY DATA SHEET
P/N - 12931206 - 1 MD PLATE CONFIGURATION

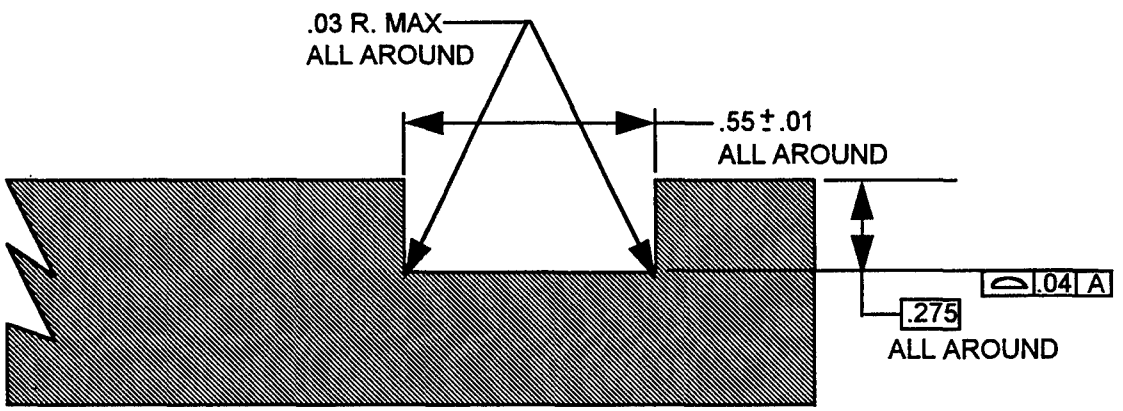


BLOW-OFF PANEL

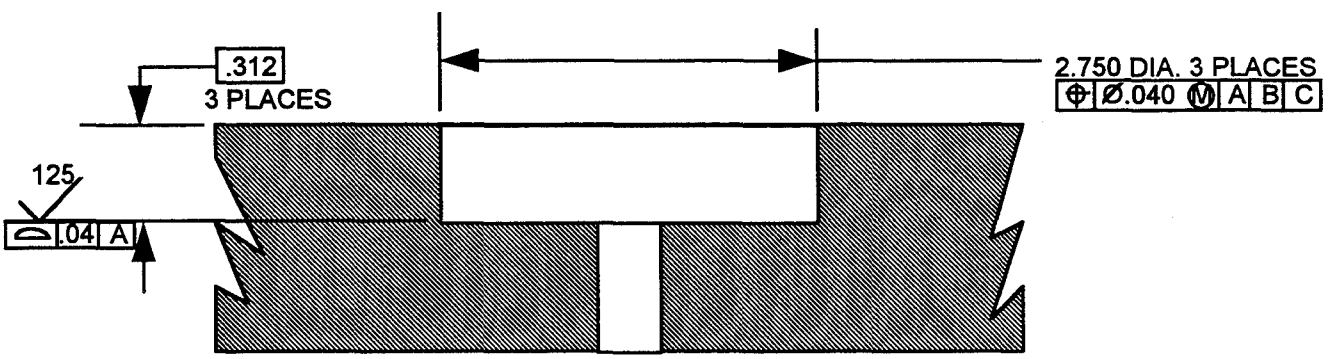
IMPROVED HARDNESS RHA MACHINABILITY
P/N - 12931206-1 MD PLATE CONFIGURATION



SECTION A - A



SECTION B - B



SECTION C - C

BLOW-OFF PANEL

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	1.00" DIA. TURBO MILL
MANUFACTURER	CARBOLOY
OPERATION DESCRIPTION	MILLING OF AMMO RACK HOLES

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	1200	IPM	10.0
DIA	1.00"	TEETH	

OBSERVATIONS:

THE MILLING OPERATION PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE OPERATION.

CONCLUSIONS:

THE MILLING OPERATION CAN BE PERFORMED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	2.50" DIA. CENTRE-DEX MILL
MANUFACTURER	WELODON
OPERATION DESCRIPTION	MILL 3 HOLES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	70	IPM	0.4
DIA	2.50"	TEETH	

OBSERVATIONS:

THE MILLING OF THE AMMO RACK HOLES PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE MILLING OPERATION.

CONCLUSIONS:

THE MILLING OF THE AMMO RACK HOLES COULD BE PERFORMED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 12931206 - 1MD (3 PLATES)

TOOL DESCRIPTION: 5/8 - 11 UNC SPIRAL POINT TAP

MANUFACTURER: HANSON WHITNEY

OPERATION DESCRIPTION: TAP 5 5/8 - 11UNC HOLES

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	100	IPM	
DIA	5/8"	TEETH	

OBSERVATIONS:

THE TAPPING OPERATION FOR THE LIFTING LUGS AND AMMO RACK HOLES PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE OPERATION.

CONCLUSIONS:

THE TAPPING OPERATION FOR THE 5/8 - 11 UNC HOLES COULD BE PERFORMED USING THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	17/32" DIA. STRAIGHT SHAFT DRILL
MANUFACTURER	NATIONAL TWIST DRILL
OPERATION DESCRIPTION	DRILL - 5 HOLES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	300	IPM	1.0
DIA	17/32"	TEETH	

OBSERVATIONS:

THE LIFTING LUG AND AMMO RACK HOLES WERE DRILLED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE DRILLING OPERATION.

CONCLUSIONS:

THE DRILLING OPERATION FOR THE LIFTING LUGS AND AMMO RACK HOLES COULD BE PERFORMED WITH CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 12931206 - 1MD (3 PLATES)

TOOL DESCRIPTION: 10 MM DIA. STRAIGHT SHAFT REAMER

MANUFACTURER: NATIONAL TWIST DRILL

OPERATION DESCRIPTION: REST BUTTON REAMING

TIME IN CUT (MIN): _____

HP	_____	COOLANT	_____
SFM	_____	CL	_____
RPM	200	IPM	1.4
DIA	10 MM	TEETH	_____

OBSERVATIONS:

THE REST BUTTON HOLE REAMING OPERATION PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE OPERATION.

CONCLUSIONS:

THE REST BUTTON REAMING OPERATION COULD BE PERFORMED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	3/8" DIA. STRAIGHT SHAFT DRILL
MANUFACTURER	CLEVELAND TWIST DRILL
OPERATION DESCRIPTION	DRILLING OF REST BUTTON HOLES

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	450	IPM	1.3
DIA	3/8"	TEETH	

OBSERVATIONS:

THE DRILLING OPERATION PERFORMED SATISFACTORY WITH NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP NOTED DURING THE OPERATION.

CONCLUSIONS:

THE DRILLING OPERATION COULD BE PERFORMED WITH THE CURRENT TOOLING USED ON THE CURRENT RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 12931206 - 1MD (3 PLATES)

TOOL DESCRIPTION: 7/16" DIA. STRAIGHT SHAFT DRILL

MANUFACTURER: PRECISION TWIST DRILL

OPERATION DESCRIPTION: DRILLING - 8 HOLES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	450	IPM	1.3
DIA	7/16"	TEETH	

OBSERVATIONS:

THE DRILLING OPERATION FOR THE HOLD DOWN HOLES PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE OPERATION.

CONCLUSIONS:

THE HOLD DOWN HOLES COULD BE MACHINED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	23/32" DIA., #2 MT DRILL
MANUFACTURER	PRECISION TWIST DRILL
OPERATION DESCRIPTION	DRILLING - 8 HOLES/PLATE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	200	IPM	1.2
DIA	23/32"	TEETH	

OBSERVATIONS:

THE DRILLING OPERATION FOR THE HOLD DOWN HOLES PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE DRILLING OPERATION.

CONCLUSIONS:

THE DRILLING OF THE HOLD DOWN HOLES COULD BE PERFORMED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 12931206 - 1MD (3 PLATES)

TOOL DESCRIPTION: 1/2" DIA. STRAIGHT SHAFT DRILL

MANUFACTURER: PRECISION TWIST DRILL

OPERATION DESCRIPTION: SPOT DRILL - 6 HOLES/PLATE

TIME IN CUT (MIN): _____

HP	_____	COOLANT	_____
SFM	_____	CL	_____
RPM	300	IPM	2.5
DIA	1/2"	TEETH	_____

OBSERVATIONS:

THE SPOT DRILLING OPERATION PERFORMED SATISFACTORY.

NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED

DURING THE OPERATION.

CONCLUSIONS:

THE SPOT DRILLING OPERATION COULD BE PERFORMED WITH THE

CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 12931206 - 1MD (3 PLATES)

TOOL DESCRIPTION: .558" DIA., 4 FLUTE DOUBLE END MILL

MANUFACTURER: PRECISION TWIST DRILL

OPERATION DESCRIPTION: SEAL GROOVE MILLING

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	300	IPM	2.8
DIA	.558"	TEETH	

OBSERVATIONS:

THE SEAL GROOVE MILLING OPERATION PERFORMED SATISFACTORY WITH NO EXCESSIVE WEAR OR HEAT BUILD-UP NOTED DURING THE MILLING OPERATION.

CONCLUSIONS:

THE GROOVE MILLING OPERATION COULD BE PERFORMED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE: IMPROVED HARDNESS RHA

PART NO. MACHINED: 12931206 - 1MD (3 PLATES)

TOOL DESCRIPTION: 2-FLUTE HSS END MILL

MANUFACTURER: WELODON

OPERATION DESCRIPTION: MILLING OF SEAL GROOVE

TIME IN CUT (MIN) _____

HP		COOLANT	
SFM		CL	
RPM	300	IPM	2.8
DIA	1/2"	TEETH	

OBSERVATIONS:

THE MILLING OPERATION FOR THE SEAL GROOVE PERFORMED SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE OPERATION.

CONCLUSIONS:

THE MILLING OPERATION COULD BE PERFORMED WITH THE CURRENT TOOLING USED ON THE RHA MATERIAL.

G.D.L.S. I-RHA MACHINABILITY DATA SHEET

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	FACE MILL
MANUFACTURER	CARBOLOY
OPERATION DESCRIPTION	FACE MILL PANEL SURFACE

TIME IN CUT (MIN)			
HP		COOLANT	
SFM		CL	
RPM		IPM	
DIA	12.5"	TEETH	10 CARBOLOY SEKN-42 INSERTS

OBSERVATIONS:

THE FACE MILL CUTTING PERFORMED SATISFACTORY. THE CUTTING EDGES OF THE INSERTS DID NOT SEEM TO WEAR EXCESSIVELY, ALTHOUGH THE FACE OF THE INSERTS EXHIBITED NOTABLE SIZE CHIPS REMOVED. THE SIZE OF THE CHIPS WERE APPROX. .38" DIAMETER. IT IS BELIEVED THE HARD SCALE ON THE SURFACE OF THE PLATE WAS THE CAUSE FOR THE CHIPS. THE PLATE SURFACE REMAINED RELATIVELY FLAT AFTER THE FACE MILL OPERATION, WHICH SHOWS GOOD STRESS RELIEF CHARACTERISTICS.

CONCLUSIONS:

THE FACE MILL OPERATION COULD BE PERFORMED USING THE EXISTING TOOLING, BUT ALTERNATIVE INSERTS SHOULD BE EVALUATED.